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Pleistocene shorelines in the southern and south-eastern Cape Province (Part 1)

by

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SYNOPSIS

This paper will describe the quaternary shorelines where exposed along the southern Cape coast, from the Natal border to Cape Town. In the first part all the shorelines in the Transkei and Ciskei are discussed, and the higher ones, at 30 m or over, from the Great Fish River to Cape Agulhas. Most of the sites mentioned are marine or estuarine; reference is made to riverine gravels where there has been a careful study of their relation to contemporary sea-levels. In order to establish chronological correlation with sites in the interior and with other parts of the world, stress is laid on artefacts included in marine gravels. The quaternary molluscan sequence in Southern Africa is poorly known, and little fauna has been found in the high-level beaches here discussed.

It is assumed that the Cape shorelines have been eustatically controlled, and were formed during (usually northern) interglacials; but this pattern is superimposed on a continuous emergence which may be due to local epeirogenesis or to sinking of the ocean-floor or both. The more recent shorelines would be separated by eustatic low sea-levels, for which at present there is little evidence in South Africa. Before the 60-metre shoreline (= perhaps the Cromer interglacial) eustatic marine regression was small and there was continued emergence with little fluctuation. The gravels of the 60-metre shoreline occasionally yield rolled primitive hand-axes. It appears that this shoreline has undergone practically no local warping between the Natal border and St. Francis Bay and west of Mossel Bay; but the Tzitzikama, Outeniqua and Robberg ridges have been uplifted by 40–60 m. Along this stretch it is uncertain if even the 30-metre shoreline can be recognized at its regular altitude; but the 18-metre shoreline can be traced all along the coast, which since that time has been stable. In the 30-metre gravels are occasionally found Acheulian tools. There are probably traces of a 48–50 metre shoreline, less clearly marked than those at 30 m and 60 m.

Above 60 m there are occasional occurrences of marine gravels, rarely containing rolled pebble-tools; but they make no pattern, and in the Early Pleistocene there may have been regional warping and uplift on stretches other than the Tzitzikama and Outeniqua ranges. It has been claimed in Algoa Bay. The contained pebble-tools are adiagnostic and cannot be used as zone-fossils to separate one shoreline from another. Near Riversdale are at least five shorelines, for which are suggested correlations on altitude alone with the four recognized in Natal. Shorelines above 150 m are probably tertiary.

INTRODUCTION

A full survey of the quaternary shorelines in the southern and south-eastern Cape from the Natal border to Cape Town would be too long to insert into a single issue of the *Annals of the Natal Museum*. I am therefore dividing this paper into two parts and into seven sections, to cover distinctive geographical regions or formations which require special discussion. Four sections will be included in this part of the paper, and sections V–VII in a later number of the *Annals*.

Most of the shore-sites have been given a number, which is taken from duplicated schedules of each coastal stretch, prepared at the conclusion of field-work for the Shorelines Commission of the International Quaternary Association, under the auspices of which

this survey of South African beaches is being executed. Four schedules cover the coast described in this part of the paper, and a fifth covers section VII in the second part. The schedules were prepared hurriedly; so their boundaries do not coincide with those of the sections of this paper, defined after consideration. The schedules are

(i) Transkei, R. Mtamvuna–R. Kei, used in section I. Site numbers of the form X25;
(ii) Ciskei, R. Kei–Hamburg, used in section I. Site-numbers of three digits, the first being the last digit of the longitude;
(iii) Port Elizabeth, Hamburg–Tzitzikama Point, used in sections I, II, V, VI. Site-numbers similar to those of the Ciskei;
(iv) South Cape, Tzitzikama Point–Danger Point, used in sections III, IV, V, VI, VII. Site-numbers similar to those of the Ciskei;
(v) South-west Cape, Danger Point–Berg River, used in section VII. Site-numbers of the form C25.

As schedule-boundaries were not fixed at degrees of longitude, a few sites in different schedules have identical numbers. Site-numbers are used on the vertical and horizontal maps.

Artefacts are quoted by their inventory numbers in the Natal Museum catalogue (NM) and the Archaeological Survey, Johannesburg (Jhb).[1] Mr. Deacon has been unable to identify for me some of Breuil's material said to be in the Albany Museum, Grahamstown; nor did I have the opportunity in 1969 of searching for them in the Musée de l'Homme, Paris, which was then closed. I have not had time to delve in the large collections in the South African Museum, Cape Town, to see if they have anything from marine gravels.

The following abbreviations are commonly used:

F.R.	Forest Reserve
H.W.M., L.W.M.	High water-mark, Low water-mark
L.S.A.	Late Stone Age
M.S.A.	Middle Stone Age
S.L. or M.S.L.	(Above) Sea-level or Mean sea-level
T.M.S.	Table Mountain Sandstone.

This paper is to a large extent a continuation of my paper on the beaches of Natal (Davies, 1970). Most of what I wrote in the introduction to that paper applies also to this one, and need not be repeated.

Thanks are expressed to the Council for Scientific and Industrial Research, which provided grants to assist my travelling expenses in the southern Cape; and to Professor O. Williams of the Department of Geography, University of Natal, who has supported my applications to the Council for Scientific and Industrial Research and has put clerical facilities at my disposal.

The seven sections into which this paper is divided are as follows:

I. *TRANSKEI AND CISKEI*

From R. Mtamvuna to the Great Fish River the coast is formed of unfolded rocks, at the northern end Table Mountain Sandstone, fairly horizontally bedded and extending for a short distance into Natal; against the T.M.S. scarp are fragments of a cretaceous

[1] In both collections artefacts have two numbers separated by a diagonal line; one of these numbers is the year of accession. Artefact numbers are used on the drawings but not on the maps.

fringe. Owing to faulting near Port St. Johns, the T.M.S. gives way to gently tilted Karroo rocks, in which marine benches can usually be recognized, though sometimes an offshore strike and dolerite intrusions make it difficult to distinguish structural levels from planations. But as most of the Karroo rocks are relatively soft, marine pebbles have not survived well and associated artefacts may have become unrecognizable. So far as it is possible to date surviving shorelines by the rare artefacts, it appears that this stretch of coast has suffered practically no differential uplift at least since the 60-metre beach (early Middle Pleistocene). It is not easy to systematize the scattered higher occurrences.

II. *ALGOA AND ST. FRANCIS BAYS, SHORELINES AT 30 METRES AND ABOVE*

West of the Great Fish River starts the zone of steeply folded T.M.S. ridges nearly parallel to the coast. The troughs are filled with Bokkeveld shales, also folded and much eroded, usually overlain by cretaceous conglomerates. There are wide expanses of cretaceous capped by tertiary and pleistocene deposits and heavily blanketed by dunes. There are marine terraces up to more than 300 m S.L.; the higher are almost certainly tertiary. Though resistant pebbles abound, it is difficult without clean sections to distinguish pleistocene beach-gravels from the detritus of older conglomerates. Artefacts in the marine gravels are scarce, perhaps because, as farther west, much of the coast was forested. Ruddock (1947, 1968) has attempted in the Sundays River valley to extrapolate sea-levels from river-terraces, a method which may be accepted with increasing reservation as one goes inland. Unfortunately, Breuil's identifications of Acheulian artefacts from the river-gravels are unacceptable, because he adopted the indefensible practice of seriating pieces as Early Middle and Late Acheulian simply on their degree of rolling (cp. the criticisms in Ruddock, 1957); there is reason to think that when he was in South Africa he was unable to distinguish water-rolled from sub-aerially weathered quartzite artefacts; and a large part of his collection can no longer be found in this country.

III. *TZITZIKAMA AND OUTENIQUA, SHORELINES AT 30 METRES AND ABOVE*

From Cape St. Francis to Mossel Bay nearly the whole coastline is formed by steeply folded T.M.S. ridges parallel to the shore. On their faces, usually heavily overgrown, marine benches can be distinguished only at very low levels. But there are marine gravels right at the summit of the coastal scarp; uplift may have continued far into pleistocene times and beaches may be considerably displaced along this stretch.

IV. *RIVERSDALE REGION, SHORELINES AT 30 METRES AND ABOVE*

West of Mossel Bay the principal folded ridges are far inland, and the coastlands extend across lower T.M.S. ridges separated by wide troughs. In places, behind the high calcified dunes which fringe the coast, long series of pleistocene and perhaps pre-pleistocene marine gravels may be traced up the gentle slopes.

V. *THE MAJOR AND MINOR EMERGENCES ALONG THE SOUTHERN CAPE*

Krige's success (1927) in tracing his Major and Minor Emergences at about 18 and 9 m S.L. along the whole southern coast of the Cape indicates that these are eustatic marine levels and there has been no tectonic movement since the earlier of them. It is illegitimate to extend Krige's term Major Emergence to any level higher than 18 m (as does Ruddock, 1957). On these two shorelines occur molluscs, including the Swartkops fauna which will

be discussed as a whole. East of the Great Fish River very little fauna has been found.

VI. *HOLOCENE SHORELINES ALONG THE SOUTHERN CAPE*

The occurrence of holocene shorelines slightly above present S.L. will be described over the whole stretch from the Great Fish River to Cape Agulhas. Two shorelines can usually be distinguished, with cliff-bases about 3,5 and 1,5 m M.S.L. They are normally rock-cut, and seldom carry beach-rock into which identifiable molluscs are cemented.

VII. *SHORELINES FROM CAPE AGULHAS TO THE CAPE PENINSULA*

Owing to convenience of access from Cape Town, the lower sea-levels have been far better studied than elsewhere in the Cape Province. In addition to printed work of varying quality, I have been able to use two unprinted theses from the University of Cape Town. Of higher sea-levels there are few traces. It is likely that the 30-metre and higher seas flooded the Cape Flats and insulated the Cape Peninsula.

I. TRANSKEI–CISKEI

The shoreline carrying the most primitive hand-axes

As in Natal, it has seemed easiest to orientate this section on the shoreline carrying the most primitive hand-axes rolled. In Natal it was demonstrated (Davies, 1970) that such artefacts occur in a beach-gravel or corresponding formation at just over 60 m M.S.L., and that the constancy of this level north of Durban indicates that there has been no tectonic movement on this coast since that time (early Middle Pleistocene). This constant level could indicate unwarped epeirogenetic uplift all along the coast; but as primitive hand-axes occur at the same level in the Mediterranean and in Europe, and it is unlikely that uplift would have been the same in such distant regions, probably the 60-metre level is of world-wide eustatic significance.

South of Durban, however, there took place since the 60-metre shoreline a small upwarp. But the level of 60 m was almost restored on R. Mtamvuna, which is the frontier between Natal and the Transkei (68 m on R. Mtamvuna, Natal 19; 67 m at Leisure Bay, Natal 102).

The shoreline at $\pm$ 60 m can be identified only at each end of the Transkei,[2] and at hardly any sites are there rolled artefacts. South of R. Mtamvuna (X2) there are pebbles and marine grit up to 61 m, probably redistributed and without cliff; also on R. Mnyameni (X09), cliff-base masked); pebbles at 58 m on R. Mzamba (X04) may be piled against a cliff. At the Msikaba lighthouse beach-gravel is exposed at 60 m (X16), and the terrain shows that the cliff-base was close; among the pebbles was an unrolled cordiform hand-axe, several probably Sangoan picks, and a crude much-rolled pick which cannot be accurately placed (NM 68/34, fig. 2, 2). There is a wide terrace up to about 61 m at Kilroe Beach (X20), and a notched cliff-base at 58 m at Lupatana (X30). South of this there is a long gap, possibly due to recent downfaulting and submergence of the coastal face.

The softer rocks south of Port St. Johns (Ecca shales, farther south-west Beaufort sandstone) would retain few traces of a 60-metre marine level. There are narrow terraces at Coffee Bay (X71) and Bashee Mouth (X86); probably also farther to the south-west

[2] The horizontal map (fig. 1) has been prepared to locate the holocene beaches, but may be used as a key to the older shorelines, which are located precisely on the vertical map.

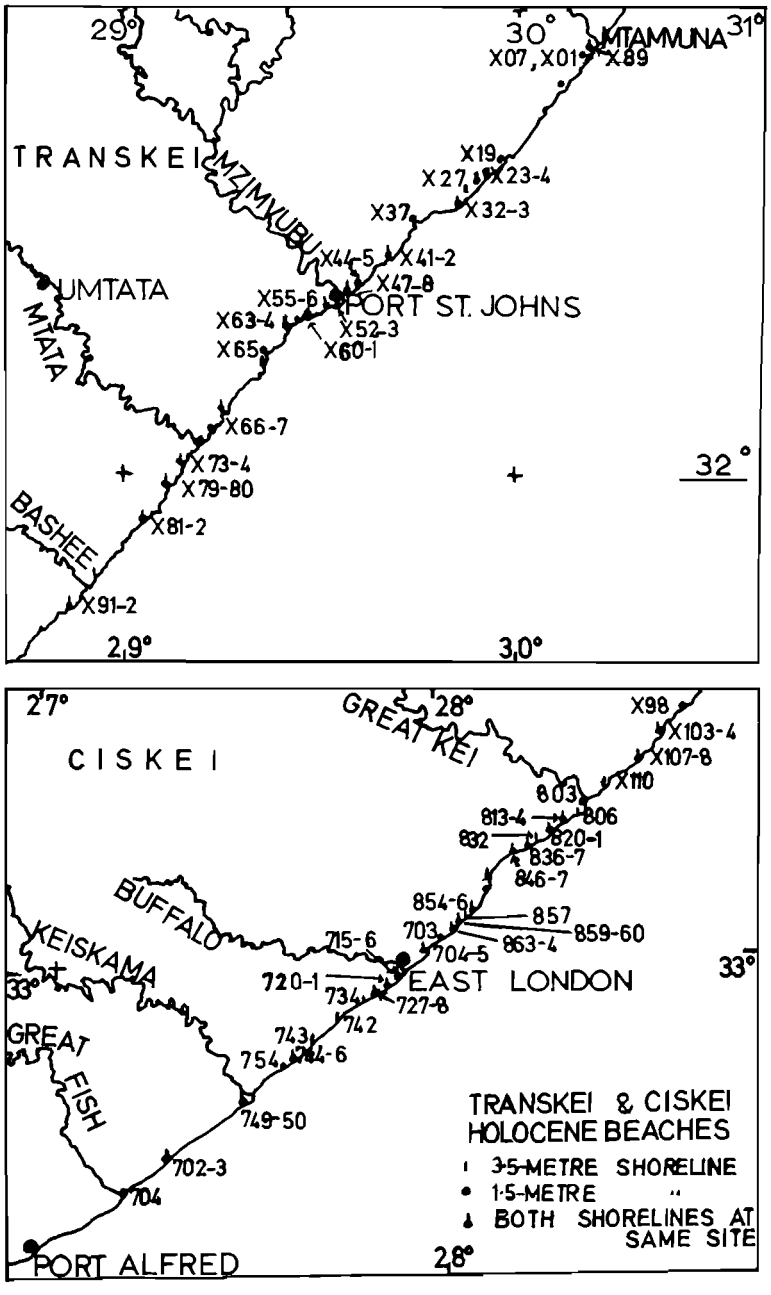
29°
30°
31°
TRANSKEI
MZIMKULU
UMTAMVUNA
X07, X01
X89
X19
X27
X23-4
X37
X32-3
X44-5
X41-2
X47-8
UMTATA
X55-6
PORT ST. JOHNS
MTATA
X63-4
X52-3
X65
X60-1
X66-7
X73-4
X79-80
32°
BASHEE
X81-2
X91-2
2,9°
3,0°
27°
28°
GREAT KEI
X98
X103-4
X107-8
X110
CISKEI
803
813-4
806
832
820-1
836-7
846-7
854-6
857
BUFFALO
703
859-60
715-6
863-4
704-5
KEISKAMA
720-1
EAST LONDON
33°
734
727-8
742
743
754
744-6
GREAT FISH
749-50
TRANSKEI & CISKEI
HOLOCENE BEACHES
3·5-METRE SHORELINE
1·5-METRE ..
BOTH SHORELINES AT SAME SITE
702-3
704
PORT ALFRED
2,8°

Fig. 1.

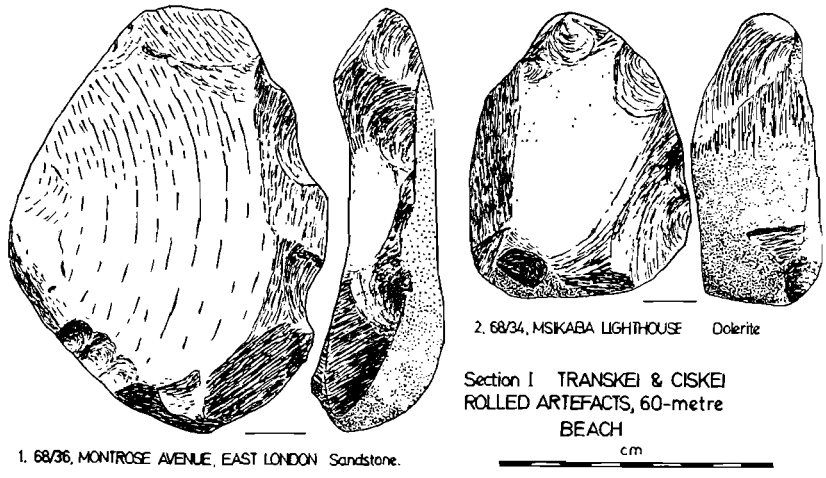

Fig. 2

(X87, X93, X99). Cliff-bases are preserved only as sharp rises in which the original form of the cliff is obscured.

The 60-metre shoreline may be slightly upwarped in the northern Ciskei. There are several exposures at 67–70 m near Kei Mouth and Morgan's Bay (801, 808, 810; see fig. 3 above). They yield only late unrolled artefacts; but this level is marked at several sites by very small T.M.S. pebbles, which may have been transported from afar by marine drift. They occur also on exposures near Hagahaga with more or less degraded cliff-base at 64–67 m (827, 835, 841, 849, 858). Here also the only rolled artefact is a possible core, atypical, from Monzi Park.

In the newly developed eastern suburbs of East London marine pebbles have been exposed at several sites just below 60 m. They disappear beneath dune, so the cliff-bases must be rather higher, apparently about 61 m at the bottom of Avalon Road and on Reynolds View, Beaconhurst (712).[3] A large area was open for examination before building started in Montrose Avenue (713). There were numerous marine pebbles on the slopes from 58 to 52 m, without any cliff being exposed. Several of the pebbles had been split and heavily rolled; but the only piece which could be accepted as a rolled artefact is a large side-scraper or more probably a very crude hand-axe (NM 68/36, fig. 2, 1). This piece is comparable to the rolled hand-axes from the same level in Natal and Zululand.

West of R. Buffalo, the industrial area of East London (717) is a wide platform abutting against a sharp rise at 64 m. The base of this cliff is masked by sand; but in a drain I saw rounded pebbles. Between here and R. Keiskama this terrace was seen at Sea View (739), with cliff and fragments of beach-rock but no molluscs.

Between R. Keiskama and the Great Fish River the only exposure is on the right bank of R. Mpekweni (712, 715, fig. 5 below). The hill being capped by dune, pebbles appear

[3] Very large well-rolled boulders in a rockery at 55 m at the corner of Galway and Kennington Roads were probably excavated in building the house, and belong to the same level.

where rock outcrops on the sides of two valleys. No cliff is exposed; but as the gravel is estuarine-marine, it may be calculated to belong to a sea-level at about 65 m. On the gravel is beach-rock containing mollusc fragments (Mountain, 1946), embedded in hard matrix whence it will take time to detach them and get them identified. There are no rolled artefacts from these gravels; one or two Late Acheulian pieces are unrolled.

Beach-exposures above the 60-metre level

It might be expected that the high-level terraces identified in Natal would continue into the Transkei. Near Port Edward these terraces are uplifted but dip markedly southward. South of R. Mtamvuna, however, little trace has been found of them. Thompson (1942: 43) claims a 190-metre terrace on R. Mzamba; at this and lower levels I was unable to distinguish more than several roughly defined surfaces without pebbles or direct evidence of marine planation. He correlates it, improbably, with a 146-metre terrace on R. Mnyameni, which I did not notice. Scattered occurrences north of Port St. Johns are recorded on the vertical map (folder 1) (X02, X08, X28), but the only traceable shoreline is at about 83 m (X03, X29), perhaps rising near Manteku store (X38) to about 90 m where rounded T.M.S. boulders must come from a terrace-gravel now unrecognizable.

South-west of Port St. Johns and into the Ciskei there are few traces of high-level terraces, and no evidence on which they can be dated. There is a platform with cliff at 116 m at Hillandale (834). Many pebbles are said to have been found at about 100 m in the foundations of the East London Museum and Guild Theatre (751; D. Lewis-Williams, pers. comm.). At Igoda Mouth (737) marine pebbles up to 88 m are derived from a beach whose cliff is higher, perhaps considerably so. The 83-metre terrace of the northern Transkei may perhaps be recognized in pebbles probably derived from the same height at Kobonqaba Location (X105) and Qolora Mouth (X109); and there may be another exposure across R. Kei in Morbay F.R. The most satisfactory indication of a 73-metre level is a line of marine pebbles on a rock-terrace east of R. Mpekweni (713). To the same level may belong a platform without cliff in Lot 47–48 behind Cove Rock (722).

The 48-metre level

In Natal there is evidence for a marine level at 48 m, and doubtfully for another at 38 m. In the Transkei I found no indication of any level between 60 and 30 m. The flat-topped ridge called Whale's Back at Hole-in-the-Wall at 43 m (X75) need not be a marine formation. In the Ciskei there is a probable platform at Morgan's Bay at 47 m (811) with gentle rise to another at 67 m (fig. 3 above); and a narrow platform at about the same altitude with rise behind at Double Mouth (816). A platform without cliff at 43 m at Hillandale (828) may belong to the same stage; it perhaps recurs at Hagahaga. Between here and the Great Fish River there is no convincing evidence for a marine level at this altitude. Cooke (1941: 20–1; see Laidler, 1934) regards the deposits at Bonza Bay (702) as lagoonal; the surface of the clay is at about 44 m, implying a sea-level not much higher. In the clay Cooke found unrolled Acheulian pieces (Jhb 13/39), fairly late but crudely worked hand-axes and cores whence flakes had been struck; in the band of pebbles and ferricrete capping the clay were unrolled pieces claimed as Fauresmith, but there is nothing typical of this

Figure 3. Morgan's Bay

Above: The 47-metre platform on the headland, with rise to 67-metre platform on right.
Below: The 3-metre and 6-metre ledges incised into the dolerite cliff.

stage and they look more like M.S.A. (Jhb 13/39/1); 60 cm higher, on the surface of a red-brown layer, was fairly advanced M.S.A. (Jhb 13/39/2). This material provides no evidence for the date of the lagoon-beds, if such they are, as the Acheulian pieces could have sunk into the clay after it was exposed.

The 30-metre level

The 30-metre level is known in many parts of the world, and has been traced without distortion in Zululand and Natal. It is believed to be the eustatic level of the Holstein interglacial. Occasionally a cliff-base is measured up to 33 m M.S.L.; this may be due to naccurate aneroid-reading.

The level has been recognized at 31 m at Port Edward Hotel and as a line of boulders on dune-sand, measured at 34 m, on the north bank of R. Mtamvuna. On the south bank, in a cutting on the national road, pebbles were observed banked against a cliff with base at 30 m (X3). Pebbles occur up to 33 m at the mouth of R. Mtentwana (X6); the cliff is masked by dune, but a spring-line indicates its base. Among them were unrolled choppers which may be Sangoan, and a small rolled piece which is adiagnostic (NM 68/26, fig. 4, 5). I did not find the bench which Thompson (1942) records at 31 m near R. Mnyameni. There are traces of a 30-metre terrace with well-rounded pebbles at Mbotyi (X34), Manteku (X39) and at the mouth of R. Mngazi (X58); I recorded no occurrence between this point and R. Kei. From here to East London are very few exposures (817, 829, 862). The absence of the 30-metre terrace over this long stretch may be due to the erosibility of the Beaufort beds and to dune-cover. For instance, excavations in the red dunes between Gonubie and R. Quinera have revealed pebbles and probably the outer part of a rock-terrace at 33 m (701); and on the road along the west bank of R. Nahoon I observed pebbles (706) on rock, overlain by red sand, up to 24 m. This is probably the slope below a 30-metre terrace which is not exposed.

On a new road to East London Eastern Beach pebbles could be traced up to a sharp rock-rise about 28 m M.S.L. (708); this would be part of the former bay of which a 58-metre pebble deposit has been described in Montrose Avenue (713).

West of East London, there are large boulders against a cliff at 30 m at Winterstrand (732), and the remnant of an estuarine terrace with a few pebbles at 30 m, 3 km up the west bank of R. Keiskama behind Hamburg (753). Between here and Great Fish River are two good exposures. At Gibraltar Rock on the east bank of the Great Fish (710), a terrace at 27 m cut in shale is overlain by 20–25 cm of poorly laid riverine pebbles (fig. 5 above); the rock-surface will be that of the river-bed, so slightly below M.S.L. I found broken pebbles, but no convincing artefacts. At Moyeni, between two branches of the Old Woman's River (714), a shale-cut terrace is overlain by 60 cm of pebbles, among which I found artefacts of Beaufort sandstone (NM 69/22, fig. 4):

lightly rolled:	1 cleaver, fig. 4, 3
	perhaps a broken hand-axe
	3 choppers, fig. 4, 1 and 4
unrolled:	2 cleavers, fig. 4, 2
	1 broken hand-axe
	1 tortoise-core
	several flakes.

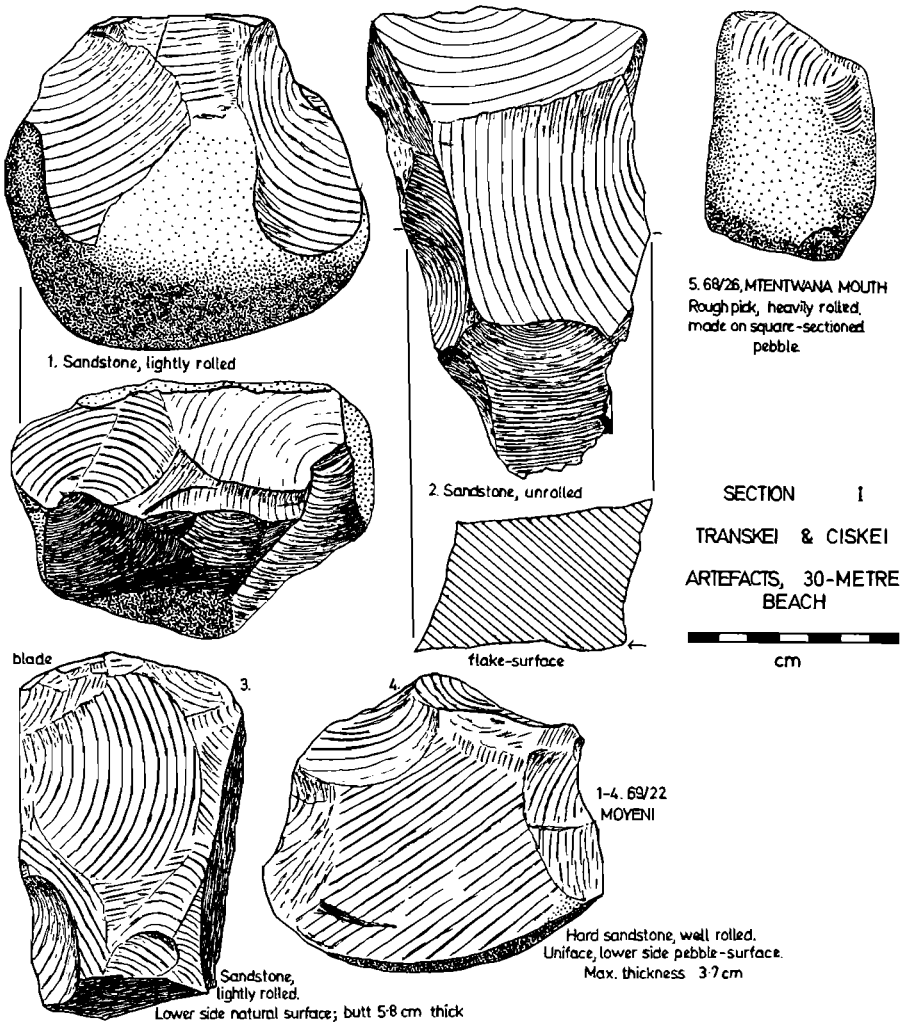

Fig. 4.

None of this material is accurately datable. Apart from one or two possibly M.S.A. pieces, the assemblage looks Acheulian, and there appears little technical difference between the rolled and the unrolled artefacts.

The 18*-metre level*

The most southerly exposure of the 18-metre level in Natal is on R. Mpenjati (Nata 076). It reappears at the bungalows on the south bank of R. Mtamvuna (X4), a gravel about one metre thick with cliff masked, and on R. Mtentwana (X7) a short way to the south. On the estuary of R. Mzamba there is a terrace at slightly below 18 m at the Forest

Figure 5. Ciskei

Above: Gibraltar Rock, left bank of Great Fish estuary, 27-metre terrace-gravel.
Below: Maitland, 61-metre terrace-gravel of R. Mpekweni.

Guard's house (X05). At the back of the red dune south of R. Mtolane (X13) a beach-gravel without cliff is exposed at 15 m; in it I found a very small rolled chopper (NM 68/29).

The 18-metre terrace with rock-rise behind reappears at Lambasi Bay near Port Grosvenor (X26). At Mbotyi (X35) the surface of a deep estuarine infill is at 20 m. The estuary had presumably been cut during a preceding low eustatic sea-level, and as the ocean rose was filled with gravel and sand. A little below the surface of the infill lay a rolled hand-axe (NM 68/25, fig. 6, 1), atypical and not closely datable.

Between Port St. Johns and Kidd's Beach scattered occurrences of marine benches, rolled pebbles and estuarine terraces enable us to envisage a continuous 18-metre shoreline (see folder 1). At a new hotel in Hillbrow Road, Kidd's Beach (740), I saw calcified beach-rock at 18 m on a ridge; the cliff had been eroded in a valley to the back. There seems to be a rock-terrace at 18 m at the hotel at Hamburg (747), and on the road to the mouth of the Old Woman's River (716). West of Great Fish River exposures are more frequent (see section V).

The 9-metre and 6-metre levels

In the southern Cape benches at 9 m and 6 m are distinguishable and probably represent independent transgressions. There are a good many benches and marine platforms along the whole length of the Transkei at maximum altitudes of 9–8 and 6,8–5,4 m.[4] At Mazeppa (Clan Lindsay Rocks, X96–7), probably Cape Hermes (X50–1; the steeply dipping shales do not preserve good surfaces), Cebe (X101–2), Nqabara (X89–90), Hole-in-the-Wall (Black Rock and The Kings, X77–8, recorded by Krige as 15–25 ft), perhaps Mbotyi and Port Grosvenor (X21–2) there appear to be marine benches at both levels on the same or adjoining traverses. At Ferry Point, Port St. Johns, there is a laid beach-gravel (X46) with cliff-base at 8 m, and at the northern end of Agate Terrace at the Ntlupeni mouth a cave at about the same altitude (X43); while up R. Mzimvubu, above The Gates, and in the town of Port St. Johns are alluvial terraces at 5,5 m (X49; Krige, 1927). No artefacts have been found associated with either the 9-metre or the 6-metre terrace.

Between R. Mngazi and Mngazana a promontory of coarse dune-rock, with base below modern L.W.M., has been marine-planed and overlaid by a beach of sand, shingle and pebbles up to 4,2 m M.S.L. (X62). There is no cliff. This is probably the 6-metre beach. The fauna is modern. Mr. R. N. Kilburn has identified

Crassostrea margaritacea — *Perna perna*
Turbo cidaris natalensis — *Tivela compressa*
Loripes clausus — *Patella cochlear*
Cerithium moniliferum Dufresne — (= *C. rugosum* Wood)
Patella sp.

There are fewer exposures in the Ciskei of beaches or platforms at 9–8 and at 6 m; at only two places did I find both levels on the same traverse (Mtendwe 830–1; Cove Rock 725–6; at neither place is the cliff of the lower terrace visible). At Cape Morgan the 6-metre platform (812) is incised into the dolerite cliff (fig. 3 below).

At East London there is evidence at least for the 6-metre beach. Krige (1927) records

[4] Thompson (1942) records a bench at 35 ft = 10,5 m (X15) just north of R. Mtentu and at 25 ft = 7,5 m between R. Mtentu and Msikaba. As this area was inaccessible to me, I could not control these figures; in both places he may have measured too high. He certainly recorded pebbles at 7,5 m south of R. Msikaba, on a terrace which Krige (1927) measured as 18 ft (5,5 m) and I as 6 m (X18).

a cave at 6 m in Second Creek, east of R. Buffalo (714), and there is a sharp nickpoint in the stream at this level. On the east bank of Blind River (752), just behind the modern shore, there is still exposed a fragment of laid gravel, sub-angular and riverine-estuarine rather than marine, about one metre thick, with base at 6 m above the lagoon or 6,6 m M.S.L. Laidler (1933) and Macfarlane (1936) claimed to have seen beach-sand overlying and partly reworking M.S.A. and Fauresmith artefacts (Jhb 7/36/1). Mr. D. Lewis-Williams informed me that he had seen the section a few months before I did. He observed horizontally bedded silts containing M.S.A. artefacts above cross-bedded silts with *Macoma litoralis*. He had found no Fauresmith pieces either on the site or in the two museums where the material is stored. When I visited the site, the lower beds were concealed, and I found no artefacts. It appears that the terrace-gravel graded to a sea-level very little lower and not far off, not to a eustatic low a long distance out to sea; and this 6-metre level (probably) was later than some phase of the M.S.A., so not older than a Würm interstadial.

The corresponding 6-metre beach is probably that exposed on Eastern Beach and round Nahoon Point (707), though its cliff is everywhere covered by dune. Mountain (1946: 37, 1966) and Deacon (1966) describe consolidated dune at Nahoon Point and Bats Cave, overlying a pebble-beach which is exposed intertidally and up to about +2 m M.S.L. On and among the beach-pebbles were found unrolled M.S.A. artefacts, some wind-blasted. The beach rests on planed dune-rock. In the dune overlying the beach, at +9 m M.S.L., were found prints of human, animal and bird feet. Shell-fragments in the dune at that level have been dated $29090\ ^{+410}_{-390}$ (SR 83).

Near the sewage-plant west of Bats Cave I observed a similar section in a shore-stack. On a fragment of pot-holed platform, here at about +1 m M.S.L., are one metre of laid dolerite pebbles covered by shelly beach-rock, which is overlain by cemented dune. In the beach-rock Mr. Kilburn has been able to identify *Littorina knysnaensis*, *Perna perna* and many barnacles, common today in this area; and Parr (1958: 107) records modern foraminifera.

The only sign of a holocene transgression round Nahoon Point is a cave and perhaps remains of a terrace cut in dune-rock at 3,6 m on the north-east side, and a notch at 1,5 m (704–5). The calcified dune overlying sand and gravel at Eastern Beach is almost certainly pre-holocene; hardly anywhere along the Cape coast is there evidence for calcification since the first holocene transgression to 3–4 m. The date obtained for the dune would not rule out a Würm-interstadial date for the beach, as dune accumulates quickly; this is suggested also by the artefacts from the beach. If the beach belongs to the Eem-interglacial, it must either have lain exposed for a long period until the artefacts were deposited, or else have been buried and completely exhumed, without surviving trace of the first sediments (probably aeolianites) which covered it.

In East London a 9-metre sea-level was nowhere observed. Not far to the west, however, at Leach Bay (719) there are rounded boulders and rocks at 9 m, with cliff masked but clearly very little higher. The terrace may be seen also at Cove Rock (725) and with pebbles at Gulu Mouth (738). On the left bank of the Great Fish River (709) the road cuts a rock-terrace overlain by a thin line of estuarine gravel. In this I found one and perhaps two rolled hand-axes which may be Late Acheulian or Fauresmith (NM 69/21, fig. 6, 2).

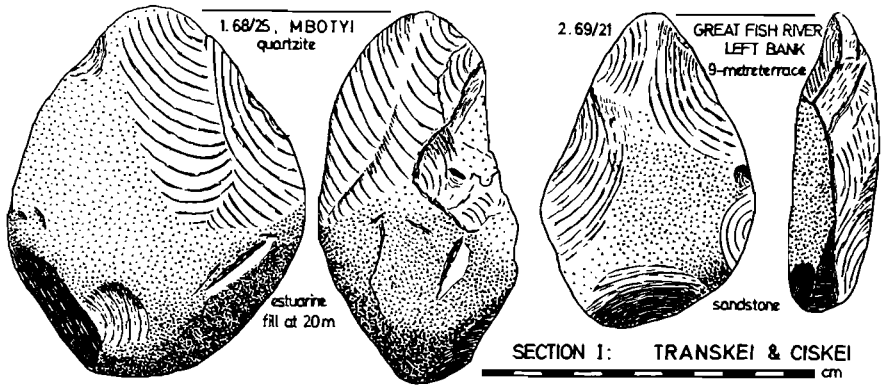

Fig. 6.

Holocene sea-levels

Marine levels were frequently observed at 3,6–3,3 m M.S.L. and at 1,8–1,5 m (fig. 1). The variations in altitude are not significant, in view of the method of measuring in integral feet (30 cm), which I have later metricized. Without long observations it is impossible to fix M.S.L. exactly at any point; so it was normally reckoned from spring high tide, on the basis of tidal range obtained from published figures for Port Elizabeth, East London and Durban, no intermediate stations being available. The average spring-range at these three ports (S.A. 1968) is 1,53, 1,44 and 1,77 m; but H.W.M. observed may have varied by 10–20 cm from the average. Nor was the fossil feature measured always the same; though all of them indicate approximate former H.W.M., a cliff-base and the floor of a notch or cave would probably be formed rather below average spring H.W.M. I have not attempted to reconstruct former M.S.L., as there is no proof of the constancy of tidal range; so all my figures are for something near former H.W.M., in relation to my approximation to modern M.S.L.

Owing to the small differences in altitude and the meaninglessness of minor fluctuations in my figures, I have not plotted the holocene beaches on a vertical map.

Holocene beach-platforms are usually not covered by soil, but exposed on or just above the modern beach. They are often overlain by mobile dune, rarely by calcified dune. They can be distinguished as planed platforms with cliff-base or up estuaries or as fragmentary platforms preserved as stacks to a constant level. Where the rock dips steeply, the platform is often dissected. Notches or small caves at the cliff-base are frequent.

Often the lower platform is incised into the upper, indicating that the two levels mark distinct transgressions. What appear to be levels other than these two have very rarely been recorded and without cliff-base. In the Mtamvuna estuary (X5) Maud (1968) mentions a rock-cut platform at 2,4 m, which I also saw; it probably marks a level in the river-bed rather than the maximum altitude of a terrace.

There are platforms with cliff-base below 1,5 m. There have in the recent past been minor fluctuations of sea-level; but it is not easy either to arrange these platforms chronologically or to decide which are due to modern wave-action. Modern waves are probably

active up to nearly +1,0 m; so altitudes of +1,0 and +0,6 m may be modern formations. It seems likely that maximum altitudes of 0 m (X25, 804, 807, 823, 840, 736, 746) and −0,6–−0,9 m (824 and others) may be distinguished as due to past fluctuations. A platform at −0,5 m between R. Mnyameni and Sikombe is being today demolished (X14); it carries a patch of shell-conglomerate which is probably fossil.

Beach-rock has occasionally been found on both the upper (749, no cliff exposed) and the lower holocene terrace (X56, X108). Fauna has been found in beach-rock on what is probably the 1,5-metre terrace at Kei Mouth (803, no cliff exposed); on the same terrace at Mgwalana Mouth (702); and on the 3,6-metre terrace at Cove Rock (727). Mr. R. N. Kilburn has in none of these samples identified any but modern fauna.[5]

Apparently unusual conditions prevailed at Kaysers Beach. Near the bathing-hut, not far west of the village, there is an uncemented beach with shell-fragments up to 1,8 m M.S.L. (745); above it probably a higher beach up to 3,6 m (744) with two incrustations 1 cm thick, each overlying fairly loose fragments of unidentifiable shell. Cemented dune carrying probably L.S.A. material appears partly to overlap the 3,6-metre beach. In the crust on the dune were modern littoral and terrestrial shells. About 2 km to the west an outcrop of dolerite has tilted the sandstones on the shore. Cemented to the rocks down to M.S.L. is beach-rock which may mask holocene terraces or may be pre-holocene.

No acceptable artefacts have been found in either of the holocene beaches. Mngazana Cave (X63), almost certainly cut by the 3,6-metre transgression, was subsequently occupied by a vigorous Coastal Smithfield population (probably a variant of Smithfield A, so not recent) (Chubb *et al.*, 1934).

II. ALGOA BAY AND ST. FRANCIS BAY, SHORELINES AT 30 METRES AND ABOVE

The 30-metre shoreline

In his survey of terraces in the Sundays River valley, Ruddock (1947) describes the Kirkwood Terrace at 25–30 m above the river, which he grades to a sea-level at 30 m (546). He identifies it mainly upstream from Addo, and describes it as rock-cut, carrying boulders and some 6 m of alluvium. Most of the artefacts collected by Breuil were associated with this terrace. At Addo Drift in particular he claimed rolled Middle Acheulian (Stellenbosch II–III) hand-axes and flakes and unrolled Fauresmith and Middle Stone Age (Jhb 100/48). At Alkom (Ruddock, Tzoetgeneugd North) and Kentvale (Ruddock, Coega Kammas Kloof) both Breuil and I collected a few rolled Acheulian pieces derived from a terrace of a tributary claimed to grade to the 30-metre level (Jhb 99/48, NM 68/41, fig. 8, 3).

I have discussed the 30-metre sea-level in section I of this paper. It appears shortly west of Great Fish River on the scarp overlooking Port Alfred station (630). On a platform cut in Bokkeveld shales there are apparently pebbles overlain by beach-rock and then by calcified dune. Mountain (1962: 9) estimates the altitude at 30 m. So far as I could deter-

[5] At Kei Mouth rather broken and worn shells, the commonest being *Perna perna*; also *Bullia diluta*; *Burnupena ? lagenaria*; *B. tigrina*; *Littorina knysnaensis*; *Nassarius capensis*; *N. kraussianus*; *Nerita albicilla*; *Ocenebra scrobiculata*; *Oxystele tabularis*; *Patella cochlear*; *Peristernia fuscotincta*; *Terebra capensis*; *Thais dubia*; *T. squamosa*; *Turbo cidaris natalensis*. At Mgwalana Mouth *Charonia pustulata*; *Mayena australasia gemmifera*; *Ostrea* sp.; *Patella* sp. (*tabularis* or *barbara*); *Thais capensis*; *Turritella carinifera*. At Cove Rock *Fissurella natalensis*; *Haliotis sanguinea*; *Oxystele sinensis*; *Patella granularis*; 2 broken and worn Mytilids, presumably *Perna perna*.

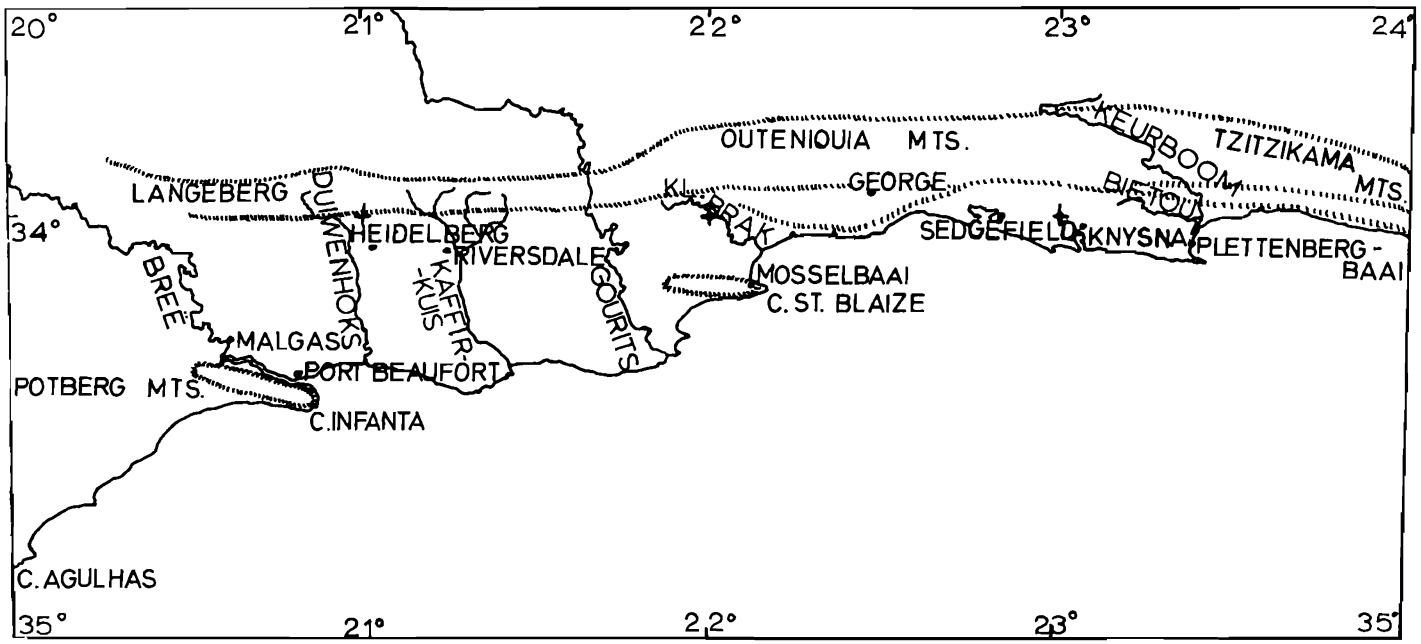
20°
21°
22°
23°
24°
OUTENIQUA MTS.
KEURBOOM
TZITZIKAMA MTS.
LANGEBERG
DUIWENHOKS
GEORGE
KLEIN BRAK
BIETOU
34°
HEIDELBERG
RIVERSDALE
SEDGEFIELD
KNYSNA
PLETTENBERG-BAAI
BREE
KAFFIR-KUIS
GOURITS
MOSSELBAAI
C. ST. BLAIZE
MALGAS
PORT BEAUFORT
POTBERG MTS.
C.INFANTA
C. AGULHAS
35°
21°
22°
23°
35°

Fig. 7 (*a*)

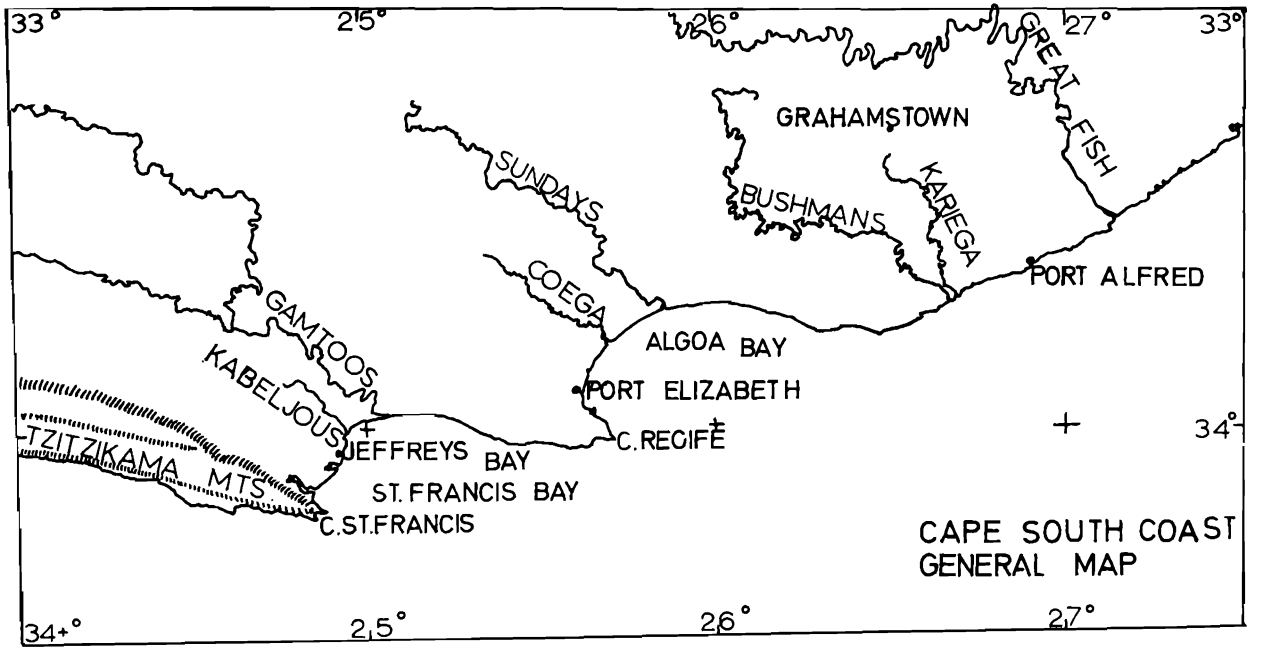
33°
25°
26°
27°
33°
GREAT FISH
GRAHAMSTOWN
SUNDAYS
BUSHMANS
KARIEGA
COEGA
PORT ALFRED
GAMTOOS
KABELJOUS
ALGOA BAY
PORT ELIZABETH
TZITZIKAMA MTS
JEFFREYS BAY
C.RECIFE
ST. FRANCIS BAY
C.ST.FRANCIS
34°
CAPE SOUTH COAST
GENERAL MAP
34°
25°
26°
27°

Fig. 7 (*b*)

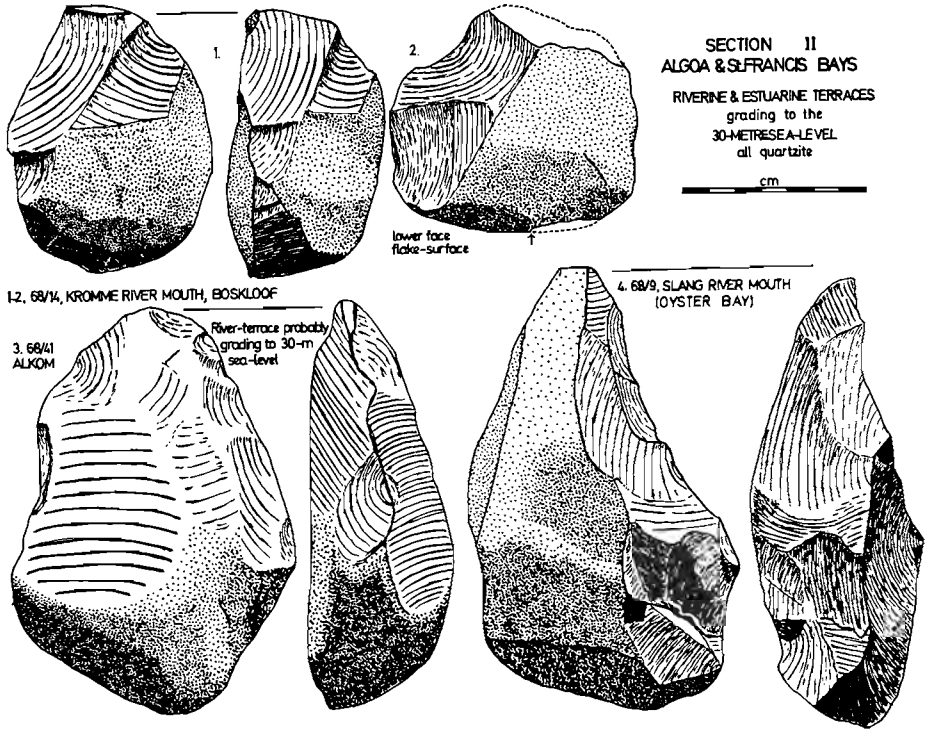
SECTION II
ALGOA & SUFFRANCIS BAYS
RIVERINE & ESTUARINE TERRACES
grading to the
30-METRE SEA-LEVEL
all quartzite
cm
1.
2.
lower face
flake-surface
1-2. 68/14, KROMME RIVER MOUTH, BOSKLOOF
3. 68/41
ALKOM
River-terrace probably
grading to 30-m
sea-level
4. 68/9, SLANG RIVER MOUTH
(OYSTER BAY)

Fig. 8.

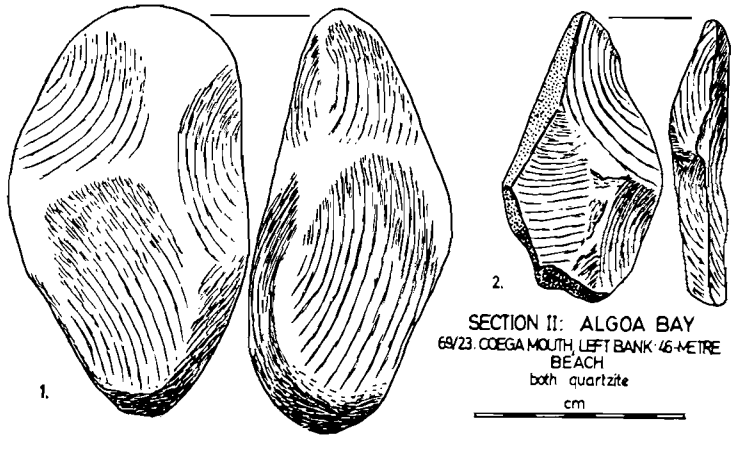
1.
2.
SECTION II: ALGOA BAY
69/23. COEGA MOUTH, LEFT BANK: 46-METRE
BEACH
both quartzite
cm

Fig. 9.

mine from the back, this is correct; but I could not approach the quarry-face to measure exactly. The platform was probably marine or at the mouth of the Kowie estuary. No artefacts were found among the pebbles which had fallen into the quarry.

In Grant's Valley flattened marine pebbles appear on several road-cuttings at 1,8–3,2 km east of the Kariega bridge at altitudes up to about 30 m (621). They rest on a terrace cut in shale, but seem disturbed, perhaps in making the road. They are covered by a little red sand, probably aeolian. Two collected (NM 68/20) have rolled flake-scars, but are atypical.

Very heavy dune-cover, especially between Boknes (on 1/50000 map Richmond) and Sundays River, precludes search for marine terraces. Wide shifting dunes overlie calcified dunes, which occasionally emerge on the shore; Engelbrecht *et al.*, (1962) says that at Woody Cape cretaceous rocks are exposed. Grassed dunes at the back contain land-molluscs and foraminifera ranging from Lower Oligocene to recent. A few valleys incised into old dune and rock are swamped near their mouths by modern dune; no exposures are deep enough to reveal pleistocene estuarine formations; the base of the Kaba valley is peaty sand at 65 m S.L., of Diepkloof about 45 m.

Even the Sundays estuary is swamped by dune. On its west bank, at the gate to Strings Home (556; probably = Melville in Ruddock, 1947) I saw two large lumps of beach-rock with unidentifiable molluscs, and many pebbles, including a heavily rolled flaked piece which may be a chopper (NM 69/24). The altitude is about 30 m S.L. The pebbles had probably belonged to a quaternary beach at the mouth of the estuary.

On the right bank of R. Coega close to the mouth is a spur at about 30 m altitude; thick bush made it impossible to measure it accurately. On its slopes are many pebbles which look estuarine rather than marine (534). Only unrolled flakes were found among them.

Within Port Elizabeth the only occurrence of the 30-metre level noticed is a terrace in Algoa Park (520). West of Cape Recife heavy dune again masks the coast.

St. Francis Bay is another trough like Algoa Bay, bounded on the south by the dune-covered eastward extension of the Tzitzikama ridge. This trough also received rivers, both from the north-west (Gamtoos, Kabeljous) and from the west (Kromme). In the Gamtoos valley at Green Acres (435) are remnants of a river-terrace at 30 m, which reappears upstream at Hankey Drift. On the left bank of R. Kabeljous near the mouth is a thick gravel, perhaps cretaceous but planed in quaternary times to 33 m. Pleistocene beach-deposits are not now visible on its surface; on the edge of the gravels I found one unrolled Late Acheulian piece. On the right bank of R. Kromme near Boskloof (411) is a steepening slope, probably a degraded cliff, overlooking pebbles at 30 m S.L.; among them were found slightly rolled and unrolled choppers (NM 68/14, fig. 8, 1–2). This may be an estuarine gravel. The terrace appears upstream at the road-bridge 25 km west of Humansdorp, at 30 m above the river. In the gravel here was found a Middle Acheulian hand-axe (Jhb 21/58).

The low ridge between Cape St. Francis and Tzitzikama Point is breached by the adjacent valleys of R. Klipdrif and Slang, along which near the mouth a rock-terrace al 30 m (401) may be traced. It is truncated by a cliff which below 24 m. S.L. is masked by dune. On the terrace is a good scatter of probably estuarine pebbles, including a rough pick (NM 68/9, fig. 8, 4), unrolled and of uncertain age.

The 48-metre shoreline

As in Natal and perhaps in the Ciskei there are near Port Elizabeth indications of a 48-metre level. Ruddock (1957) calculates a sea-level at 49–52 m (the difference is small) from a river-terrace which he claims to have traced to 10 km from the mouth of the Sundays River (Tankatara, 545); Breuil's claim of rolled Early and Middle Acheulian pieces from this and higher terraces up to 160 m S.L. must be treated with scepticism. I have observed a similar level north of Algoa Bay. At Amsterdam Plein there is a wide platform at 52 m with pebbles and sharp rise at back (533); but along the cliffs on the left bank of R. Swartkops I could not distinguish a break of slope. There is probably a beach at 48 m at Hougham Park (540); the terrace is incised into calcified dune, and is covered by pebbles and beach-rock, in which Mr. Kilburn recognized shells of *Nassarius speciosus*. On the left bank near the mouth of R. Coega (554) is a terrace at 46 m, with cliff incising a higher terrace. Among the pebbles were shells of unidentifiable Ostreidae, and two artefacts (NM 69/23, fig. 9), a rolled point and an extremely rolled hand-axe.

On R. Kromme there is a 48-metre terrace backed by a sharp rise above Boskloof (410), at the top of a slope into which the 30-metre terrace is incised; it is at 52 m S.L. and about 45 m above the river 1 km above the head of the modern estuary at Rosa (406).

The 61-metre shoreline

In Natal and the Ciskei I have treated this shoreline as the level of reference, on which there occur rolled the most primitive hand-axes. Near Port Elizabeth no artefacts have been found in beaches at this altitude except pieces collected by Breuil from the Sundays River terraces. Ruddock's most recent article (1968) presumably presents his final conclusions about these terraces. He says that during a sea-level at 58 m there occurred in this area tilting and regional uplift of 29 m. He is not prepared to say if 58 m is the maximum of a single transgression or of two transgressions to the same altitude. He also postulates a transgression to 64 m. The difference is so small that the two levels might be part of a single transgression, especially as Ruddock's calculations span fairly long distances.

On valley-floors, which he assigns to both the 64- and the 58-metre transgressions, Ruddock, following Breuil, records a very few rolled Acheulian artefacts. Without illustrations and details of locality we cannot accept the claim that some of them are Acheulian II and III; that rolled Acheulian I occurred on terraces grading to these sea-levels is not unreasonable and is paralleled in Natal. Ruddock's failure to record details of artefacts and fauna associated as zone-fossils with higher sea-levels renders his dating little better than guesswork. He sets out in detail a geological sequence, without fixed points with which to correlate it.

At Swarte Koppen a bed of beach-rock, shells and pebbles at least $2\frac{1}{2}$ m thick (552)[6] rests on a terrace cut in clays (fig. 10 above) and abuts against a cliff with base at 61 m. No artefacts were found. Mr. Kilburn has been able to identify the following molluscs:

[6] 6 metres according to Engelbrecht *et al.*, 1962: 23, 25–6.

extinct in South Africa

Crassatella (not a recent sp.)	*Cypraea* sp.
Glycimeris africana	*Isognomon* cf. *gaudichaudi*
'*Chamelea*' (= ? *Pitar*) *schwarzi*	

now living in South Africa

Schizodesma spengleri	*Turritella* sp.

On the assumption of the identity of the site I saw with that described by Engelbrecht *et al.*, the following further species are recorded by them:[7]

Ancilla sp.	*Barbatia alfredensis* (*B. obliquata*)
Bittium tropicale	*Barbatia* cf. *textilosa*
Bullia annulata	*Barbatia* sp.
Conus cf. *proliferatus*	'*Chamelea*' *krigei*
Conus sp.	'*Chamelea*' *rogersi*
Donax serra	*Glyphis elevata* (*Diodora elevata*)
Lyncina cf. *carneola*	*Ostrea* sp.
Tivela baini	*Psammobia* ? *vespertina* (*Gari* ? *depressa*)
Turritella bicarinata	coral
Turritella cf. *knysnaensis*	

At about the same altitude as Swarte Koppen and 2 km to the west Breuil (1949) reports from a gravel (570) not quite *in situ*, very rolled, two small pointed hand-axes and three pebbles doubtful as artefacts, unrolled a few Acheulian pieces. I have been unable to trace the rolled pieces which he claims. I found one lightly rolled pebble-chopper.

At Hougham Park are pieces of beach-rock on calcified dune at 60 m (539). I am uncertain if they are *in situ*. The 46-metre terrace at Coega Mouth (above, 554) is incised into a higher terrace (555) whose cliff is masked by dune; it may be the 60-metre level. Similarly, at Amsterdam Plein (532) there is a terrace at 60+ m with no cliff. These occurrences justify Ruddock's claim for at least one sea-level at about this altitude.

The spur on which stands Fort Frederick in Port Elizabeth appears to be a fragment of an estuarine terrace (522). It is below the 200-foot contour and I measured it as 55 m. But mean sea-level may have been higher, so it can reasonably be associated with the 60-metre shoreline.

West of Port Elizabeth traces of probably estuarine terraces occur in the Gamtoos and Seekoei valleys (Uitkyk 55 m, 501; and perhaps at 67 m, 436; The Glen at 61 m, extending eastward towards Jeffreys Bay, 409). A detailed survey of the Gamtoos valley might well yield a sequence as informative as that of the Sundays River.

Shorelines above 61 *metres*

If Ruddock's assumption (1968) of diastrophism in the Sundays valley is correct, shorelines above 58 m, even when calculated from the gradients of river-terraces and corrected according to the assumed tectonic movements, cannot be safely correlated by altitude with those in distant regions. Nor, in absence of detailed studies of other valleys, can we

[7] Engelbrecht's lists for Swarte Koppen and Brakke Rivier (below) have been emended by Mr. R. N. Kilburn, with modern names of species included in brackets. Chamelea is put in inverted commas because the assignation to this genus is now uncertain.

Figure 10. Port Elizabeth area

Above: Swarte Koppen, 61-metre beach.
Below: Altonadale, 185-metre beach.

guess the extent of tectonic movement or assume that it was everywhere of equal intensity. It is first necessary to consider the high plains behind Port Elizabeth and in the Gamtoos valley.

Ruddock calculates three Late Cainozoic sea-levels corresponding to terraces and surfaces near the Sundays River, the Salt Pan Terrace with maximum sea-level at 107 m (altitude after tilting about 119 m), the valley-floor intersecting the Bont Rug escarpment with S.L. $\geqslant$ 90 m, and the Bont Rug Plateau with maximum S.L. of 84 m (altitude after tilting about 92 m). The Salt Pan Terrace is 1,6 km wide and abuts against an escarpment from about 165 to 119 m (today), which incises the Grassridge Plateau. This is probably a composite formation, covered with a veneer of marine deposits containing abundant *Ostrea* (Haughton, 1928); there is no direct evidence that it is as recent as quaternary. The Salt Pan Terrace is separated from the Bont Rug Plateau by a gentle escarpment 15 m high. The Bont Rug Plateau is a composite formation, on which Ruddock claims a series of beach-ridges of an intermittently retreating sea, apparently without eustatic fluctuations to low levels.

Ruddock claims rolled hand-axes on river-gravels correlated with shorelines up to the top of the Bont Rug Plateau (calculated about 84 m). In Natal there are terraces at 82 and 73 m; but neither of them yield Acheulian pieces. So much has been discovered about the Early Pleistocene that Zeuner's classification of sea-levels (1962: 128), which Ruddock quotes, is out of date. He hesitatingly places the beginning of the Quaternary at the Bont Rug escarpment. This view, based on the occurrence of artefacts, is anthropocentric and unsupported by recent research. Hays *et al.* (1969), using as a chronological yardstick the dated series of magnetic reversals, show that the beginning of the Quaternary as defined by marine microfauna is approximately contemporary with the Olduvai Event, about 1,8 m.y. B.P. There are human artefacts at Olduvai; but they are not the first artefacts ever made. In fact, the earliest beach in Natal to yield artefacts is at 155 m, certainly older than the Bont Rug Escarpment (Davies, 1970: 407–8).

The Salt Pan Terrace and the higher part of the Bont Rug Plateau seem equivalent to Ruddock's Colchester Plateau east of the Sundays River. This plateau dips gently seaward from 125 to 60 m without noticeable escarpments or breaks of slope. Stow (1871) records *Ostrea* in the marine deposits. Mountain (1962) describes a similar plateau between Bushmans and Kariega Rivers. To the west there are fragments of probably marine terraces at varying levels, none of which may easily be correlated with Ruddock's sequence; there may have been diastrophism also round St. Francis Bay.

The base of the Salt Pan Escarpment is calculated before diastrophism as 107 m. Above it is the long slope of the Grassridge Plateau, with which a few beach-occurrences may be correlated. A marine platform apparently abuts against a cliff at 155 m at Welgelegen (438). At Altonadale (566) flattened T.M.S. pebbles, overlain by a metre of sandy silt, rest on a rock-platform at 185 m (fig. 10 below). They are well sorted and probably a beach *in situ*; no cliff is exposed. At least the upper stretches of the Grassridge Plateau above 200 m, carrying gravel and shells, mostly *Ostrea* (Engelbrecht *et al.*, 1962: 22), should be Late Tertiary, at Addo Heights (Haughton, 1928) and on the hills above the Gamtoos mouth (e.g. behind Mondplaas station to 280 m) (Haughton, 1925: 28). The gravel at about 220m at Van Stadens Bridge (506) may be the remains of cretaceous conglomerate.

The official view on the pliopleistocene boundary, expressed by Engelbrecht *et al.* (1962), accepts Krige's antiquated stages (1927) of Major and Minor Emergence, behind which everything is tertiary, including the whole of the Alexandria Formation down to 18 m S.L. Ruddock regards the latter as marine beds, pliocene at high levels and pleistocene lower down, resting discordantly on the Cretaceous. He assumes a single long regression, due either to epeirogenesis in Southern Africa or to continuous fall of absolute S.L., and cannot produce evidence for glacio-eustatic fluctuations before the Würm. I present evidence below that these fluctuations were unimportant until after the 60-metre sea-level; but even minor fluctuations would incise cliffs into beds which had been laid down offshore. So I suspect that, were deep trenches to be cut, the Alexandria Beds would on any traverse be found to consist of a complex sequence of shallow-water and littoral deposits, representing a number of sea-levels of the Early and lower down of the Middle Pleistocene.

The faunal list compiled by Engelbrecht (1962: 25–6), on the assumption that the whole Alexandria Formation is tertiary, is difficult to use, because it gives no indication of altitude or localization of collecting-places more precise than a farm-name. It is impossible to sort out what shells were found at each level; so I have not included their sites on the vertical map. At Swarte Koppen they may have collected at the same site as I did (61 m, 552). From levels below 60 m must come the small collections from Amsterdam Hoek and Vetmaak Vlakte. The productive site of Redhouse Fish Water Flats may be at any level from 73 m downwards. Mormons Heuvel site must belong to the 61-metre or 73-metre level, and yielded *Pirenella stowi*, *Bullia annulata*, '*Chamelea*' *rogersi*, *Isognomon* cf. *gaudichaudi*. The productive site of Brakke Rivier seems to have been near the top of the Bont Rug Plateau, so is older than Swarte Koppen; its fauna listed by Engelbrecht is:

Ancilla sp.	*Barbatia alfredensis* (*B. obliquata*)
Bittium tropicale	*Barbatia nivea* (*B. foliata*)
Conus sp.	*Barbatia* cf. *textiliosa*
Ostrea sp.	*Barbatia* sp.
Pecten sp.	*Fissurella incarnata* (*F. mutabilis*)
Pirenella cf. *stowi*	*Glyphis elevata* (*Diodora e.*)
Schizodesma spengleri	*Psammobia* ? *vespertina* (*Gari* ? *depressa*)
Tivela baini	*Turritella bicarinata*
coral	*Turritella planitextilosa*
Voluta ponderosa (*Lyria africana*)	

The site of Welbedachtsfontein was probably higher, but within what I assume to be the pleistocene range.

III. TZITZIKAMA AND OUTENIQUA

Shorelines below 100 *metres*

The coast between Tzitzikama Point and George is bounded by two very steep ridges, in front of which is in places a narrow foreshore; elsewhere the waves wash the foot of the cliff. Along the eastern half, as far as Plettenberg Bay, the Tzitzikama Ridge is over 100 m high, in many places over 200 m, and is incised by narrow precipitous gorges. It is extremely inaccessible; it seems that there are practically no high-level marine terraces on its outer face below the crest. At the mouth of R. Keurbooms, in Plettenberg Bay, the inner ridge

continues inland, separated from an outer ridge, which terminates at Robberg, by a trough 6–10 km wide drained by R. Bietou. Near Sedgefield the outer ridge disappears; the inner ridge, with a wide foreshore partly filled by lakes, again forms the coast to near George.

Along the Tzitzikama coast the evidence consists entirely of caves. A number have been recorded at 18 m and lower (see section V). A few are at anomalous altitudes. Krige (1927) records caves at Huisklip at 18 and 24 m (401–2), both of which he claims as marine. At the mouth of Groot R. he mentions two large caves at 22 m (418), which I could not distinguish. Turner (1970) gives a profile of a cave on the east side of Groot Rivier (Nature's Valley), whose floor he estimates at 23 m; the cave may be marine, but it is doubtful if it was accurately measured.

The conventional levels are poorly represented on the Tzitzikama coast. At the east end of Hengelaarskroonstrand (409) there appears to be a fragment of a terrace at 27 m. Above the east bank at Nature's Valley (317) there is perhaps a terrace with cliff at 60+ m; but I could not reach it to check its nature and altitude. The O.S. shows that some streams east of Storms River debouch at about 60 m on the cliff-face. Krige (1927: 9) records a narrow terrace extending for 30 km between Groot and Storms R., cut in T.M.S. and Bokkeveld shales on the face of the Tzitzikama cliffs (301) at an altitude of about 90 m. He quotes Schwarz (1905: 65); but as the two accounts differ, Krige may himself have seen the terrace at a time when the coast was less inaccessible than today. Schwarz indicates that it is cut in shales, and the cliff at its back is T.M.S.; it may therefore not be a marine terrace, but formed by differential erosion. Turner's drawing (1970: fig. 2) of the Coldstream Cave at roughly 75 m M.S.L., if it is trustworthy in detail, suggests marine erosion.

Shoreline along the top of the Tzitzikama cliffs

Perhaps however the whole range has been uplifted not long before the 18-metre S.L., as has almost certainly happened at its western end, near the Keurbooms mouth. T.M.S. beach-pebbles are exposed at 107 m on the lip of the scarp at Maulbach on the road to Hengelaarskroonstrand (408); a narrow terrace cut in shales is backed by a rock-rise of about one metre, probably the stump of a cliff. Among the pebbles I found unrolled Late Acheulian pieces but no rolled artefacts. At no other point was I able to reach the edge of the scarp.

In a comparable situation and altitude beach-remains have been found at the extreme western end of this long cliff, close to Keurbooms R. The most informative section is on cuttings on the old road from Plettenberg Bay to Humansdorp, now a track through the Forest Reserve which rises steeply from Keurbooms Bridge. For a stretch of about 400 m, at altitude 111–105 m S.L. (332), are exposed three overlapping bands of small flattened pebbles, rising gently landwards and in places well laid (fig. 11). These are typical of a regressive sea, and the pebbles differ in shape size and bedding from those of the underlying cretaceous conglomerates. The oldest and lowest band dies out on the planed surface of the Cretaceous without cliff; but some 200 m farther north along the track small flattened marine pebbles reappear at 122 m S.L. (331). There being no continuity on the road-cutting, I could not prove that this exposure forms part of the same beach. Above 122 m there are

Figure 11
Keurboomsrivier Forest Reserve, the three lines of pebbles of the 111–105-metre regression-beach.

no further pebbles. A fairly sharp rise of the shales may be a degraded cliff; but it may mark the fault-scarp between the cretaceous and Bokkeveld beds, clearly visible on the lip of the Keurbooms gorge (see Macfarlane, 1958).

Along the exposure I found unrolled Acheulian pieces. One piece, which lay not far above its lowest point, about 105 m S.L., seems to be a rolled primitive hand-axe (NM 69/2, fig. 12, 1).

Mortelmans (1945) describes on this track a 400-foot (122-metre) platform cut in Uitenhage Beds. His site 7 could be my site 331. He describes the section as

A. Thin band of black sand with M.S.A. at base (Jhb 73/43)
B. Thin zone of lateritic nodules
C. 1–2 m of alternating gravels and red sands
D. Uitenhage Beds.

In level B he found unrolled pieces of Late Acheulian, and at its base a primitive cleaver apparently unrolled (see his fig. 7).

The present national road climbs the scarp more gently from the Keurbooms Bridge, and crosses the junction of Bokkeveld and Cretaceous at about 86 m S.L. The exposed surface of the shales carries scattered pebbles; but its unevenness makes it probable that it is a surface of erosion and not a marine terrace. The shales are capped by red dune from about 93 m to the top of the hill.

There at 128 m the road traverses a narrow saddle and passes from dune on to shales which rise landward. The red dune is capped by thick ferricrete or yellowish dune, with

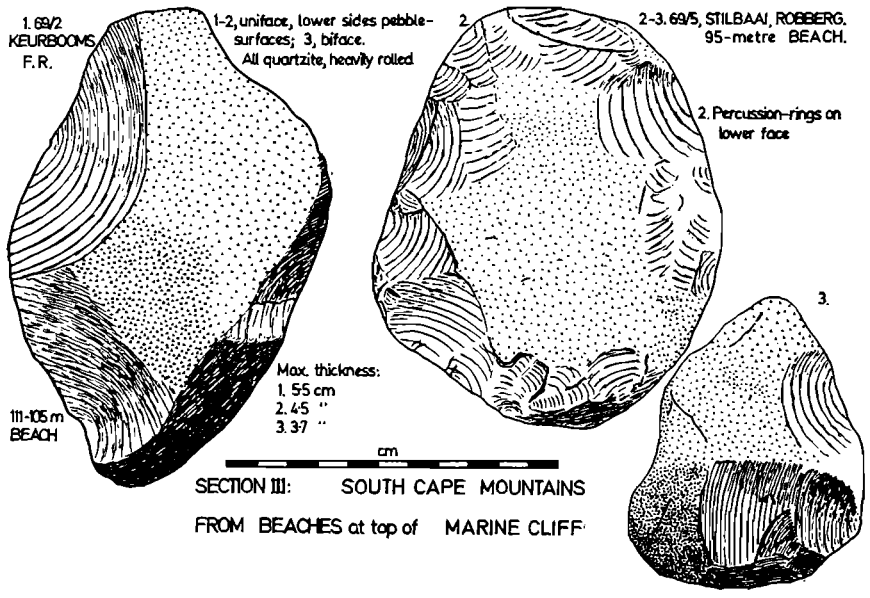

Fig. 12.

unrolled Late Acheulian at base of the ferricrete (NM 69/4) and M.S.A. flakes on its surface. This saddle may well mark the cliff of the 122-metre platform (330).

Mortelmans marks as site 2 (Coupe du sentier) this saddle or a site shortly to the west. He describes a section in the red dune with unrolled Late Acheulian, overlain by dark soil with M.S.A. (Jhb 69/43–69/43/2).

From site 2 Mortelmans continued his traverse inland, roughly along the line of the national road, until he joined the old road through the Forest Reserve. On the slope he found scattered Late Acheulian derived from now eroded dune or ferricrete (Jhb 70/43), and at site 3 he found with well-rolled beach-pebbles what he claims as rolled Early Acheulian hand-axes, uniface picks and large flakes (Jhb 71/43); the only pieces I could identify in Johannesburg from this site are unrolled Late Acheulian. The topography has been altered by the construction of the national road. I found beach-pebbles on this stretch only at 200 m altitude on a wide shelf cut in shale 200 m south of the gate to Indraai (329).[8] They do not appear to be a beach *in situ*; they are overlain by colluvial gritty sands capped by ferricrete nodules with further pebbles. I found at this site only a single unrolled chopper. So the association of rolled Early Acheulian artefacts with this beach-gravel is doubtful. The shelf rises gradually inland; near Conford, about 5 km from Indraai, pebbles cease near where T.M.S. replaces shales. No beach and no cliff is exposed; the beach must have been below 213 m S.L.

There are probable marine terraces abutting against a steep rise at 168 m at Bergys. On Hanglip, the hill west of the Keurbooms mouth, is a wide terrace from 122 to

[8] Indraai is not marked on 1/50000 3323 CD. The gate is beside a lane leading to Basjanskraal and other farms at 33°59′15″ S. Conford is marked on the map as Ashlands.

150 m, cut in cretaceous conglomerates. Near its outer edge, I saw beneath a little dune-sand small flattened pebbles which look marine (334), and contrast with the large ill-rolled cretaceous boulders. This must be the continuation across the river of the beds described in Keurbooms F.R. (331 and perhaps 332).

The abundant unrolled Late Acheulian artefacts in Keurbooms F.R. give no indication of the date of the two beaches at about 122 and 200 m; they merely prove the presence of man in this area and his utilization of convenient pebbles. The single rolled piece from about 106 m (fig. 12, 1) and Mortelmans' rolled pieces from nearly 200 m, if they can be accepted as Acheulian, indicate anomalous levels for both beaches. There must have been great uplift near R. Keurbooms, as perhaps all along the Tzitzikama ridge.

Such uplift could explain the absence of acceptable marine terraces along the scarp-face. Macfarlane (1958) speaks of terraces at 60 and 30 m close to R. Keurbooms; I could find no trace of any between 18 and 100 m. There are scattered pebbles above the 18-metre platform at Keurboomsstrand, but no evidence whence they were derived. Mortelmans (1945, site C) describes sites with artefacts on the talus behind Hotel Frederick, close to the Keurbooms mouth. I could not identify these sites; I think that none of them are above 18 m S.L. There is now a large quarry just west of the hotel, apparently in a bed of ill-rolled estuarine pebbles, among which I found two fairly convincing rolled artefacts, a crude hand-axe and a large core. These may be derived from the beach high up the scarp, but are no indication of an intermediate sea-level.

The Outeniqua ridge

The main ridge of the Tzitzikama–Outeniqua Mountains is fronted on the seaward side by a second ridge between Robberg and Knysna, but again forms the coast from west of Knysna to west of George, where beyond another trough the Mossel Bay ridge provides a new sea-front. As on the Tzitzikama coast, the Outeniqua ridge is a chain of mountains overlooking a fairly wide peneplain with steep scarp to the sea. Again, there are beach-remains at varying altitudes on the scarp, but no artefacts in the gravels by which to date them.

Behind Wilderness Lakes the scarp-edge is at 195 m between Hoekwil and Wilderness. The new road to Hoekwil has revealed small and large pebbles at the edge, resting on a terrace of rotten T.M.S. (211). At the extreme top the pebbles are mixed with orange sand and rolled grit; this deposit gives way abruptly to grey sand containing rolled laterite-nodules. This point seems to mark the cliff-stump, the grey sand being a terrestrial formation on the peneplain behind the shore. Further back there are in places T.M.S. pebbles, but they do not appear to be of marine quaternary origin, and are probably cretaceous fill. At only two other places did I notice possibly marine terraces of comparable altitude:

In Rheeboksfontein A west of Groot-Brakrivier (236) a wide shelf from about 160 to 177 m is covered with fairly well rolled pebbles; it is dissected at the back, and there are no exposures of undoubted beach.

In Buffelsfontein A (224) there is a scatter of marine-looking pebbles in a valley at 177 m, derived from somewhat higher.

These levels may be comparable with the beach at about 200 m at Indraai (329). There are traces of beaches at lower levels at the top of the scarp:

(*a*) about 145 m:

225. Flattened small and medium marine pebbles, apparently at the top of a beach, on an irregular schist-cut terrace about 50 m wide at Brakfontein Coast west of Herolds Bay.

223. Concentration of flattened pebbles up to 144 m in New Buffelsfontein Coast, cliff-base masked by dune.

West of Wilderness and the Swart River, where the coast trends south-east, the edge of the peneplain is at about 150 m, with valleys sharply incised into it at Victoria Bay, Ballots Bay, Herolds Bay, and as far as Glentana. At no points other than those mentioned did I find pebbles on the edge of the scarp to indicate the position of the beach.

(*b*) about 135 m:

220. Wide platform with perhaps degraded cliff, carrying well-rolled T.M.S. pebbles, at Gwaingrivier estuary.

227. Patch of flattened marine pebbles without cliff at Hoogekraal.

217 perhaps. At Groothoek platform with a few pebbles but no cliff up to 128 m, perhaps part of the 135-metre level.

(*c*) about 120 m, perhaps comparable with the 122–105 metre beach at R. Keurbooms:

226. White pebbles, probably estuarine, at 122 m on a platform at Brakfontein Coast. The deposit is below and probably independent of 225, marking a different stage in the development of the estuary.

On the Outeniqua coast there are caves with probably notched cliff at 30 m at Rooiklip Point near Groothoek (218), and a cave at the Gwaingrivier estuary (221). Pebbles up to 24 m at Victoria Bay (213) appear derived, perhaps from a 30-metre level destroyed by erosion. These sites suggest that tectonic uplift on this part of the ridge ceased before the 30-metre sea-level (probably = the Holstein interglacial). On the Tzitzikama coast the evidence is not clear, on R. Keurbooms it is lacking; but as the scarp facing Plettenberg Bay is formed of soft cretaceous deposits, marine-cut caves may have disappeared.

The Robberg–Knysna ridge

On and behind Robberg Peninsula are several probably marine-cut caves, at Robberg at about 30 m (341), at Stilbaai at 52 m (346). At the car-park at Stilbaai are rounded pebbles, several with chatter-marks, deposited probably at the head of a small bay at 95 m (345). Among them were found a rolled hand-axe and cleaver (NM 69/5, fig. 12, 2–3) and other rolled pieces which are not certainly artefacts. Typologically these pieces seem more advanced than the crude Early Acheulian artefacts which appear in the 61-metre beach of Natal; but if the 52-metre cave corresponds to the 48-metre S.L. in Natal, the 95-metre beach can hardly be later than the 61-metre stage in Natal. It would therefore appear that the Robberg ridge was strongly uplifted just after the 61-metre stage, and the uplift had perhaps not finished at the time of the 48-metre level.

Behind the 95-metre beach at Stilbaai is a marked platform with probably cliff at 110 m. I saw no marine deposits on it.

Along the ridge west of Robberg are scattered pebbles at 120–130 m. A section on the national road out of Plettenberg Bay at 128 m (340) reveals pebbles against a cliff which is

probably due to faulting and not marine. They would have lain on the old surface.

No trace of high-level beaches was found at Knysna Heads or Noetsie. Much of the coast west of Plettenberg Bay is difficult of access and was not visited.

IV. RIVERSDALE REGION, SHORELINES AT 30 METRES AND ABOVE

Mossel Bay–River Gouritz

Along this stretch the coast is determined by several roughly parallel ridges of Table Mountain Sandstone, which project eastward to form promontories. All lie in front of the main Cape range, the Langeberg, which is a continuation of the Outeniqua range behind George. The troughs between the ridges are partly filled with marine, estuarine or terrestrial conglomerates which are believed to be of tertiary age (Wybergh, 1919), overlain by fairly thin quaternary deposits.

At Mossel Bay are indications of a 30-metre shoreline. Behind the lighthouse are three caves, which Krige (1927) put at 27 and 33 m (255). The large cave (fig. 13 above) was excavated by Goodwin and Malan (1935), yielding a Middle Stone Age industry called after the site. Krige's measurements seem inaccurate. Dreyer (1934) and Goodwin–Malan give 30 m, with which I agree. Krige makes out that the cave is sub-aerial, its location at the junction of T.M.S. and Enon conglomerate being a point of weakness where sub-aerial erosion might start. This theory seems tailored to support the assumption, now discredited, that there are no pleistocene shorelines in South Africa higher than 18 m. The other two caves are smaller, and their floors are at about 36 m; the walls of one appear waterworn. Above Tonnelgrotte, south of the Golfcourse, is a ledge on a promontory at 30 m (258). It cuts across the bedding of the rock, and is probably part of a marine platform, the cliff having been removed in a valley behind it.

Gatehouse (1955) records pebbles at 30 m S.L., apparently on the lower road out of Mossel Bay towards George. These I could not find, and Gatehouse could not determine whether they are *in situ* or derived. They may well be a further indication of the 30-metre level round the promontory.

Fransmanshoek Point is largely formed of calcified dune, which apparently rests on rock at about 30 m. In view of the steeply dipping T.M.S. beds, I could not determine if there are remains of a rock-terrace at this altitude.

There may be an estuarine terrace of R. Gouritz at Melkhoutfontein slightly above the 30-metre contour (113). Numerous pebbles rest partly on rock, partly on calcified dune. Among them are only a few unrolled flakes.

Along the Gouritz estuary are many pebbles derived from a level of about 60 m at Melkhoutfontein, and a long exposure of the terrace, rather below 60 m, on both banks farther upstream near Johnsons Post (108); among the pebbles on the right bank I found what appears to be a crude rolled pick (69/8, fig. 14, 1). The pebbles appear up to 54 m also on a long slope of yellowish sands along the road to Kanon (Cape Vacca), probably just outside the old estuary of R. Gouritz (101). I could not here find rolled artefacts; one or two unrolled ones are atypical.

Pebbles occur occasionally above 55–60 m:

(*a*) At the top of Victoria Park, Mossel Bay, many pebbles apparently rest on a narrow terrace at 92 m S.L. (251). Dune seems to mask the face of the cliff. This is almost certainly

Figure 13. Riversdale region
Above: Cape St. Blaize, Mossel Bay, cave at 30 metres.
Below: Melkhoutkraal on Kafferkuils, calcified 61-metre beach on rock-terrace.

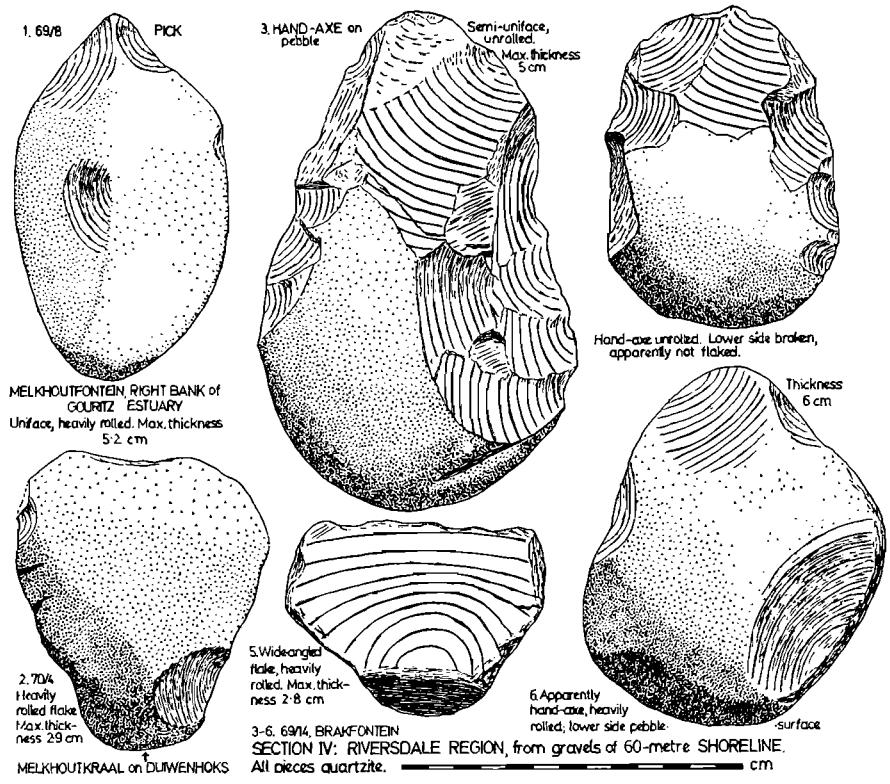

Fig. 14.

the deposit recorded by Gatehouse (1955). Among the gravel I found several unrolled uniface Middle or Late Acheulian hand-axes; and one heavily rolled piece which is probably an artefact, of uncertain type and date (NM 69/6, fig. 16, 1).

(*b*) There appears to be a terrace with numerous flattened pebbles at Voëlvlei on the left bank of R. Gouritz a short way upstream from its present tidal limit (111). The maximum altitude is about 110 m. As the valley narrows through a poort just above this point, it could well be gravel at the head of a former gulf or estuary. No artefacts were found.

(*c*) It is unlikely that the gravels exposed on the railway and national road just above Gouritz poort are estuarine. They are ill-rolled and ill-sorted. Three levels can be distinguished:

(i) At Milepost 181 on the right bank gravels and calcified sands 6 m thick rest on a rock-terrace at 73 m S.L. (apparently >60 m above present river-bed, which I could not reach). One rolled borer was found on the surface of the gravel (NM 51/53), not certainly an artefact.

(ii) Close to Gouritz station on the right bank, a wide spread of poorly rolled pebbles at 100 m S.L.

(iii) On the left bank a gravel at 128 m S.L. filling a rock-cut channel 5 m wide and 1,5 m deep (107). This may belong to the first incision of the poort, which below 130 m S.L. contracts to a precipitous gorge.

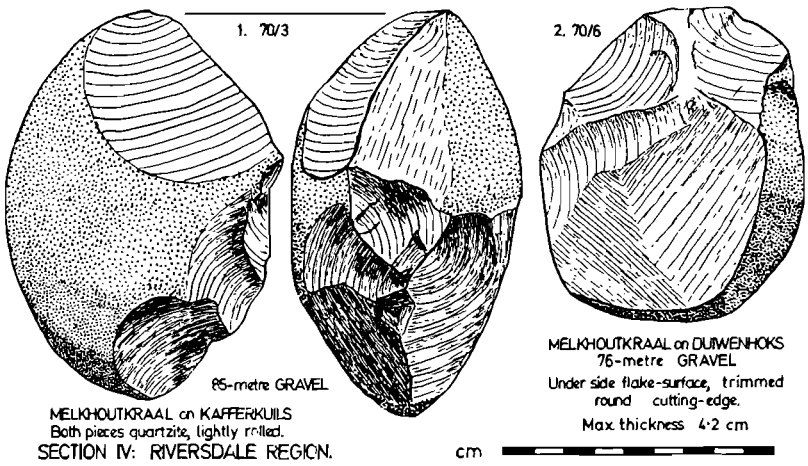

Fig. 15.

(*d*) At and below the Clubhouse at Mossel Bay Golfcourse was a site known to Breuil (1945: 362–4, 1948: 62) and to Power, who collected unrolled Late Acheulian pieces for Kimberley Museum. It appears from Breuil's not very explicit accounts that there was a marine gravel at a reservoir on the road to the Clubhouse (250), at an altitude which he gives as 450 ft (137 m) and 260 ft (79 m); from the 1/50000 map it must have been above 120 m. In it he found rolled trimmed flakes, which he illustrates. The site has since been covered, and I saw no pebbles. About 30 m higher, in the pine-wood on the golfcourse, were numerous pebbles and unrolled Late Acheulian hand-axes on calcified dune. The pebbles had presumably been carried to this point, and a re-used rolled artefact which Breuil found is irrelevant to the question of sea-levels.

(*e*) There are many flattened pebbles at the head of what seems to have been a trough between two ridges, at Riet Valley (264) 10 km west of Mossel Bay on the national road. They extend up to an outcrop of T.M.S. at 158 m S.L. Layers of pebbles interspersed with water-laid sand occur about 5 km to the west at Duinzicht, at what was measured as a slightly lower altitude.

The Riversdale area

The plain south-west of Riversdale has one of the finest series of high-level beaches in South Africa, Before describing them, I must dispel certain misconceptions publicized by Macfarlane (1949).

Macfarlane reports gravel containing rolled pebble-tools behind Riversdale at Verkykerskop (summit 1,123 ft = 342 m), Klipberg (1,090 ft = 332 m), Kleinplaatjie (945 ft = 288 m), and Trigonometrical Beacon 92 (821 ft = 250 m). He attempted to project these ridges parallel to the modern deeply incised valleys and so to calculate sea-levels corresponding to the gravels. This method is unsound, as river-profiles on these steep foothills are and have been irregular. The gravels are poorly rolled, and may be described as torrent-gravels rather than river-gravels. I found similar gravels covered by vegetation in Garcia

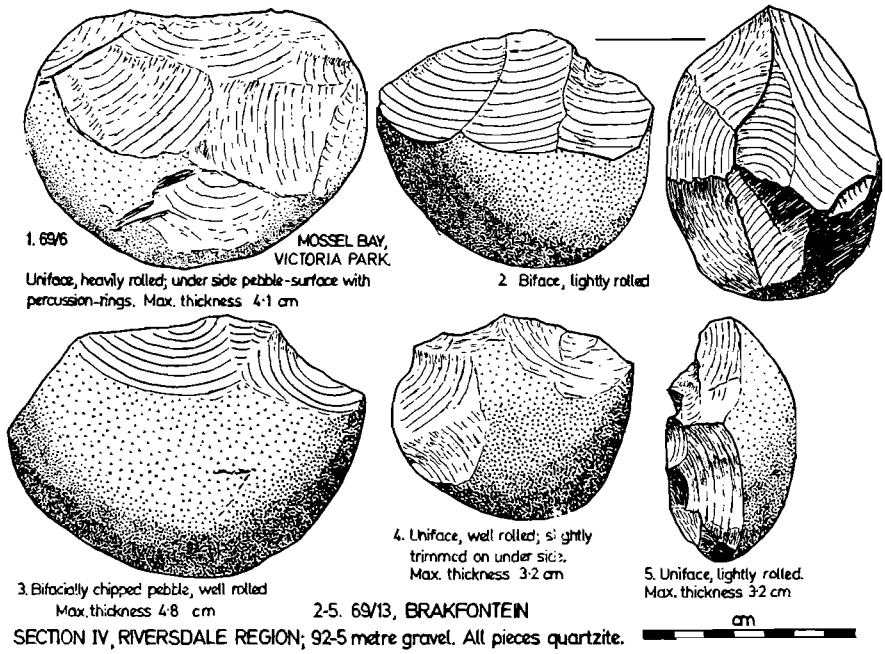

Fig 16.

F.R. up to 380 m. Some may have been spread from the poort of R. Vet. They are not marine, and not necessarily quaternary.

Macfarlane records hilltop gravels also near Swellendam and Napier, which he tries to compare with modern valleys grading to present sea-level, and claims contain rolled pebble-tools. These claims must be treated with caution. In fact, there are pebbles everywhere around Swellendam, at all altitudes. While some have been derived into quaternary river-terraces, most are probably relics of a cretaceous filling, unassociated with the present river-pattern.

In 1953 Macfarlane showed me his collection of what he claimed to be rolled pebble-tools from Verkykerskop and Klipberg; it appears that some of them had been accepted as artefacts by Breuil (Van Riet Lowe, C., pers. comm.). I could find nothing acceptable save unrolled Acheulian pieces at Klipberg.

There are large deposits of gravel just east of Riversdale at a lower level. Near the Airfield most pieces are unrolled or very poorly rolled; but at one place a wide rock-platform at 216 m S.L. is covered by fairly well rolled pebbles, not marine. On the slope such pebbles are incorporated into lateritized water-borne sands. I am uncertain if this is really the base of a cretaceous fill. Among the pebbles I saw what appeared to be pick-like artefacts, slightly abraded; but in view of the uncertainty of this gravel, I would hesitate to accept them.

Nearly 1 km farther south are again ill-rolled gravels on Jakkalskop at 204 m S.L. Macfarlane collected from here what he considered to be rolled artefacts, and in 1969 I

found two heavily rolled pieces (NM 69/9), one of which may be a primitive hand-axe. Near the surface of the gravel are unrolled Early Acheulian pieces. These gravels cannot be associated with any defined ancient sea-level.

Breuil (1948: 67) claimed a line of beach-pebbles with heavily abraded and stained artefacts and unrolled Acheulian and pebble-tools at Ligtenbos on the road to Albertinia at 195 m S.L. I have been unable to identify this place, and Breuil's altitude is probably erroneous. The records of the Archaeological Survey (4/45) describe the site as at 137 m S.L. on the old road, probably therefore in the upper valley of the Soetmelksrivier or one of its tributaries. The only artefact in this collection is a lightly rolled T.M.S. chopper. Breuil may have seen gravel-spreads in Hoëkraal and Polance at 159–153 m, which seem to be cretaceous fill reworked on an old flood-plain of the Soetmelksrivier.

Macfarlane and Breuil claimed marine gravels sectioned by the main road (119) at Soetmelksrivier (5,1 km from Riversdale, alt. 152 m, about 64 m above present river-bed) and at Skoongeleë (close to the Stillbay turn 14 km from Riversdale, alt. 143 m). In the former there are rolled artefacts; Breuil collected rolled Early Acheulian and unrolled Middle Acheulian (see NM 69/10); in the latter he found only atypical pieces. The former site as exposed on the road is clearly the filling of a river-channel; the Skoongeleë gravel is probably riverine. I have no evidence as to the sea-level with which these gravels were associated. In general, it appears unlikely that the sea transgressed far south-east of Riversdale, so the gravels probably belong to an advanced stage of R. Kafferkuils. If there were rolled hand-axes at Soetmelkrivier, this site is unlikely to belong to a level higher than 60 m, i.e. to a mouth at Melkhoutkraal (121, see below).

South-west of Riversdale towards R. Duiwenhoks is a wide gently sloping plain, bounded on south by high calcified dunes, which mask all marine terraces near the coast. It is cut in Bokkeveld shales, heavily lateritized, and thinly covered by concentrations of well-rolled pebbles, usually separated by changes of slope which may be stumps of cliffs. Wybergh (1919) claims that the pebbles are very old and were reworked with the formation of the calcified dunes; he suggests that the marine shells among the pebbles (which I have not noticed) were introduced when the dunes were formed; or they may have been midden-accumulation. Along the northern edge of the dunes he says that the pebbles are overlain by red sands up to 30 m thick; these appear to be decalcified dune.

In my opinion, the pebbles, perhaps ultimately derived from cretaceous conglomerates, are the remains of a regressive beach or beaches of quaternary date. The earliest quaternary transgression may have cut or exhumed the wide shale terrace, which could be much older. The transgression extended up to a steeply scarped ridge whose base is at about 180 m S.L. at Brakrivier se Hoogte (135). This scarp may be the Early Pleistocene cliff, though at its base are sub-angular pebbles, not apparently marine. At the back of the ridge, along the national road between Riversdale and Heidelberg, are ill-sorted sands and gravels. I did not see pebbles at a corresponding altitude between Heidelberg and Vermaaklikheid; but there is a deposit of white flattened pebbles at 195 m in Drooge Valley (003) south-west of Heidelberg, lapping against a higher peneplaned surface with scarcely a trace of a cliff. At Hillsdene (002) there is a scatter of well-rolled pebbles on a plateau at 206–213 m, which seems to break away to a lower surface at about 196 m, probably the same as in Drooge Valley.

I found on the plain between R. Kafferkuils and Breë indications of marine levels, marked by pebble-concentrations and usually by changes of slope, at 60, 76, 85, 97, 110, 128 and 143 m. These figures are rather close together, and I cannot be certain that all represent independent transgressions. If however I can demonstrate that the 60-metre level, noticed also on R. Gouritz (108, above p. 212) contains artefacts of the same Early Acheulian stage as in Zululand, there will be a presumption that it is an unwarped glacio-eustatic or epeirogenetic level, and it may be justifiable to correlate higher levels also. Shorelines below 60 m are masked south of Riversdale and Heidelberg by high calcified dunes; but in the gap between the dunes and the Potberg they can be identified in the Breë valley.

There is a large concentration of pebbles at the northern foot of the dunes not far east of R. Duiwenhoks at Brakfontein and Melkhoutkraal (146–7); they end inland in a fairly steep rise covered by calcrete. They are well rolled, and though not noticeably flattened, I consider that they are a beach-shingle. At Brakfontein I collected (NM 69/14)

rolled: 1 piece much rolled which may be a hand-axe (fig. 14, 6)
2 flakes, one heavily, one lightly rolled (fig. 14, 5)
several pebbles with one or two flakes removed;
unrolled: 2 hand-axes (fig. 14, 3–4)
2 large outside flakes
several cores, 2 of M.S.A. type.

At Melkhoutkraal was one rolled flake (NM 70/4, fig. 14, 2) and perhaps a rough pick, no unrolled pieces.

Where a road crosses the Kafferkuils gorge there is a narrow exposure of rock-cut terrace and pebbles at 61 m in Melkhoutkraal (121). Calcified dune covers the cliff. On the west bank in Klipfontein the terrace is distinguishable. On the east bank there is a layer of pebbles 30 cm thick, partly incorporated in the calcrete incrustation of the rock (fig. 13 below). Many are small and flattened. No artefacts were found. This gravel is marine or estuarine.

At 3,2 km along the Port Beaufort–Swellendam road is a marked rise, probably an old cliff, from a terrace with top at 52 m to another at 59–67 m in Rhenosterfontein (014). This terrace abuts at 4,2 km along the road on a rise to a higher terrace. It is cut in shale and carries pebbles but no artefacts. The 61–7 metre terrace appears also near Malgas Bridge over R. Breë (012). There is a good spread of pebbles but no artefacts. At this point it is presumably estuarine.

The continuation of the 61-metre terrace across the Kafferkuils gorge at Melkhoutkraal suggests that incision of the gorge had not yet started and the river-mouth was roughly on the level of the terrace. This evidence is not available for R. Duiwenhoks and Breë, but is suggested by the contours. This implies that though the gorges have subsequently worked backwards from the 60-metre shore, strong glacio-eustatic fluctuations started only after this sea-level, i.e. probably in the Mindel glaciation, and previously there had either been a steady drop in ocean-level or a steady epeirogenetic rise in Southern Africa, or both combined.

There is some evidence on R. Kafferkuils and Duiwenhoks that valley-entrenchment was slight up to the 30-metre stage: in Kransfontein there are remains of a fairly wide V-shaped valley down to 40 m, steeply incised by subsequent marine regression. Fairbridge (1961, 132–3) suggests that sea-level as late as the Mindel glaciation did not drop below

that today; I am uncertain about his correlation, as he puts the Milazzian (± 60 m) in the Holstein interglacial; but if in fact it equates with the Cromer, his curve still implies that there was no deep entrenchment before the Mindel, as suggested here. There is similar evidence on R. Mtamvuna (Natal).

On the road to Riversdale from Brakfontein the next pebble-concentration marking a shoreline is on the same farm at 95 m S.L. (145). On other traverses two intermediate levels, at 76 and 85 m, were noticed; similar levels, at 83 and 72 m, were observed in Natal (Davies, 1970).

A 76-metre terrace was seen only at Melkhoutskraal on Duiwenhoks (144). Above the calcrete-covered rise from the 61-metre beach there is a pebble-concentration at 70–76 m, ending again in a fairly steep rise covered in calcrete. In this gravel I found several unrolled broken pieces, and one side-scraper or chopper (NM 70/6, fig. 15, 2) which appears lightly rolled.

A shoreline at 82–85 m was observed at Melkhoutkraal on Kafferkuils (120), exposed over a short distance but with cliff masked by calcified dune. It is incised by a cliff of which the base is covered; this may be the cliff of the 61-metre terrace (121) or of an intermediate shoreline which is buried in the dune. Among the pebbles I found a rolled chopper and flake and an unrolled chopper (NM 70/3, fig. 15, 1). At Rhenosterfontein, above the 58–67 metre terrace (014), is a wide terrace exposed at 79–82 m, the cliff having been removed by the Slang valley (011); it is covered with small pebbles, and can be traced on the Port Beaufort–Swellendam road at 4,6–6,6 km from the crossroads. No artefacts were found on it. The road from Port Beaufort to Heidelberg traverses at Vondeling (004) a wide terrace at 73–82 m covered with well-rolled pebbles, some cemented in calcified water-laid sand. I saw one piece of *Ostrea* which may be contemporary, and a heavily rolled pebble-chopper (NM 69/11). There is no cliff; at 82 m the pebbles are replaced by thick calcrete resting on clay, which is probably terrestrial. At Dassenklip (143) is a wide expanse of pebbles at 82–98 m, separate from the 76-metre beach in Melkhoutkraal (144), and perhaps divided into two gravels by a slight change of slope at 85 m. South of R. Breë mouth pebbles were seen behind St. Sebastian Point (019) at about 79 m; dune masks their landward side, so they probably come from a beach whose maximum altitude was higher.

The next level observed is at 95–98 m. This level was seen in Zululand only at Ninians station (Natal 843, 845), where being a single occurrence it was regarded as estuarine and not an independent sea-level. However, its recognition at three sites near Riversdale suggests that it is a genuine level.

In the northern part of Brakfontein (145) there is a wide scatter of pebbles on a very gentle slope up to 95 m S.L., where they stop against a slight steepening which may be a cliff-stump, giving way to shale and calcrete. They are well flattened; among them I saw a large block of beach-rock which had apparently been extracted from a dam. The bottom of the exposed beach seems to be at about 92 m, below which the slope steepens markedly. Among the pebbles are several slightly rolled and unrolled choppers (NM 69/13, fig. 16, 2–5); unrolled hand-axes with pebble-butts were found, Early or Middle Acheulian.

At the south end of Dassenklip is a spread of pebbles (142) up to a marked rise at 98 m, which separates them from a higher spread which I assign to an independent level up to 110 m without cliff (141). The 98-metre terrace extends across R. Duiwenhoks into Dassjes

Klip (001). There may be another terrace inland of Dassjes Klip in Bosheuwel; but pebbles were seen only at 101 m, dug out of a cattle-grid. No rolled artefacts were found in any of these gravels.

There appears to be evidence for a beach at 122–130 m, though this was not identified in Natal; in gravels at this altitude no rolled artefacts were found. At Jakkalsfontein (137) are well-flattened pebbles up to 128 m on a marked slope capped with thick laterite. Farther to the east is a concentration in Kleinheuwel (138) up to 122 m; but there appears to have been erosion, and the original altitude may have been 125 m or more. The absence of intermediate levels south of Kleinheuwel until the 61-metre terrace at Melkhoutkraal is due to old dune-rock on the plateau west of the Kafferkuils gorge. At Rooiklaasheuwel–Oude Muragie is a wide spread of pebbles, dying out on the slope at 130 m without trace of cliff (140).

The highest beach-level identified below the base of the scarp at 180 m is a level at 145 m, which may correspond to the 155-metre shoreline in Natal. There is a wide platform on both roads at Pienaarsrivier (139), calcified and heavily lateritized rock overlain by a thin spread of medium and small pebbles. They extend up to 143 m without cliff. Among

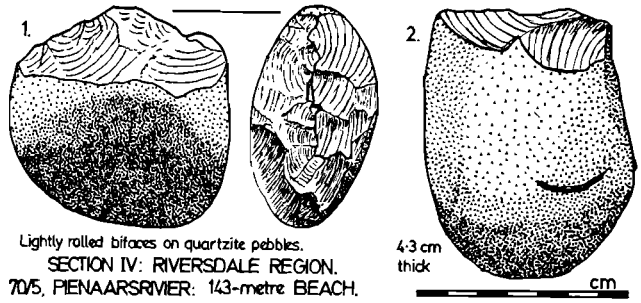

Fig. 17

them I found many unrolled broken pieces and pebble-choppers, and two hand-axes probably Late Acheulian; a very few of the pebble-choppers seem to be lightly rolled (NM 70/5, fig. 17). There are similar pebbles without cliff up to 142 m at Uitkyk (136). At Droërivier there is a slight steepening with concentration of large pebbles just below it at 145 m. This may mark the junction of two gravels, the higher extending to about 170 m near the base of the scarp, and the lower belonging to the 145-metre level. A wide surface at Morelig at 113–150 m, abutting on a fairly steep rise, may be part of the same terrace; it carries a few pebbles.

In the Kafferkuils gorge the west-bank road at the east end of Klipfontein sections an estuarine deposit of heavily calcified gravel, sand and shells; its surface is at 49 m, and it is 3–4 m thick. Mr. R. N. Kilburn has recognized in it only *Ostreidae*. There is another deposit of pebbles in Kransfontein at 33 m, belonging to the next sea-level. At Melkhoutfontein (122) the Stillbay road sections a rock-surface on the edge of the gorge at 27–30 m; it is irregular, and may be the eroded edge of a 30-metre terrace, covered by dune immediately to the back. In the Duiwenhoks gorge I traced a small and medium riverine gravel

at Vermaaklikheid up to 35 m above river, but could find no evidence to what sea-level it grades.[9]

In the Breë valley, however, there is better evidence for sea-levels at both 52 and 33 m. An estuarine gravel at 52 m can be traced near Jakkalsfontein (005) on the road north from Port Beaufort, and in Rolhoek on the Swellendam road (006). Among the gravel in Jakkalsfontein I found an unrolled hand-axe, probably Late Acheulian; and a dubious rolled piece which may also be a hand-axe. South of R. Breë on Cape Infante is a terrace with pebbles at about the same level at Stilbaai and near St. Sebastian Point (020).

The 33-metre terrace carrying pebbles is well marked on both banks of R. Breë at

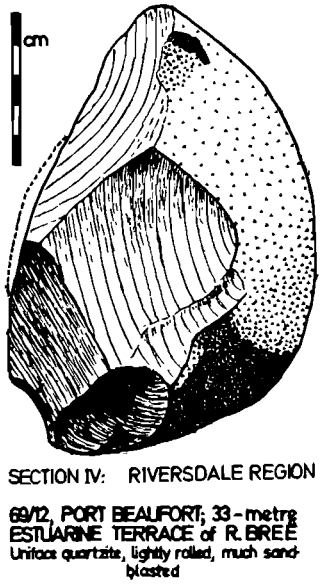

Fig. 18

Port Beaufort. On the left bank (007) pebbles extend for several hundred metres away from the estuary to a rise, clearly seen on the Heidelberg road. Among them I found a crudely flaked piece, perhaps rolled and much wind-blasted, possibly a rough hand-axe (NM 69/12, fig. 18). On the south bank the terrace is obvious up to 33 m (015), but carries few pebbles. Krige (1927) records at Cape Infante a cave at 30 m (021) which he considers structural rather than marine-cut. Schwarz (1905: 81) says that a boulder-beach appears

[9] Breuil (1948:68) describes a stained gravel with unrolled Acheulian, beneath later cultures, on Farm Brakfontein, in a cleft which he learnt by hearsay was about 24 m S.L.; he considered this to be an exposure of the 30-metre terrace. His text implies that he went with Dr. Heese to Stillbay at the mouth of R. Kafferkuils, not towards R. Duiwenhoks. The O.S. map shows no Brakfontein in the Kafferkuils gorge. There is one, which I have described regarding the 60-metre beach, not far from R. Duiwenhoks; but on this farm the only cleft below 30 m S.L. is a little valley between Brakfontein and Melkhoutkraal, in the bottom of which I saw no gravel. The material that Breuil collected is Jhb 32/45, which Van Riet Lowe (1945) describes as bipolar L.S.A., presumably from an upper level of the site. It appears that no sense can now be made of Breuil's account.

above the cave at 30 m; this may mean that it is cemented into the cave-roof. I did not identify the cave.

Along the Potberg I noticed well-flattened small pebbles at 93 m S.L. at Elandspad on the track to Noetsie (022), and beach-pebbles cemented in dune-rock at 30 m above Noetsie (023). At the former site I found one unrolled hand-axe, perhaps Middle Acheulian; at the latter nothing older than M.S.A. In general, the southern ridge of the Potberg is formed of cemented dune.

West of the Potberg as far as Cape Agulhas the coast is low. I nowhere found traces of beaches higher than 18 m. Heavy dune largely conceals the original land-forms.

To be continued

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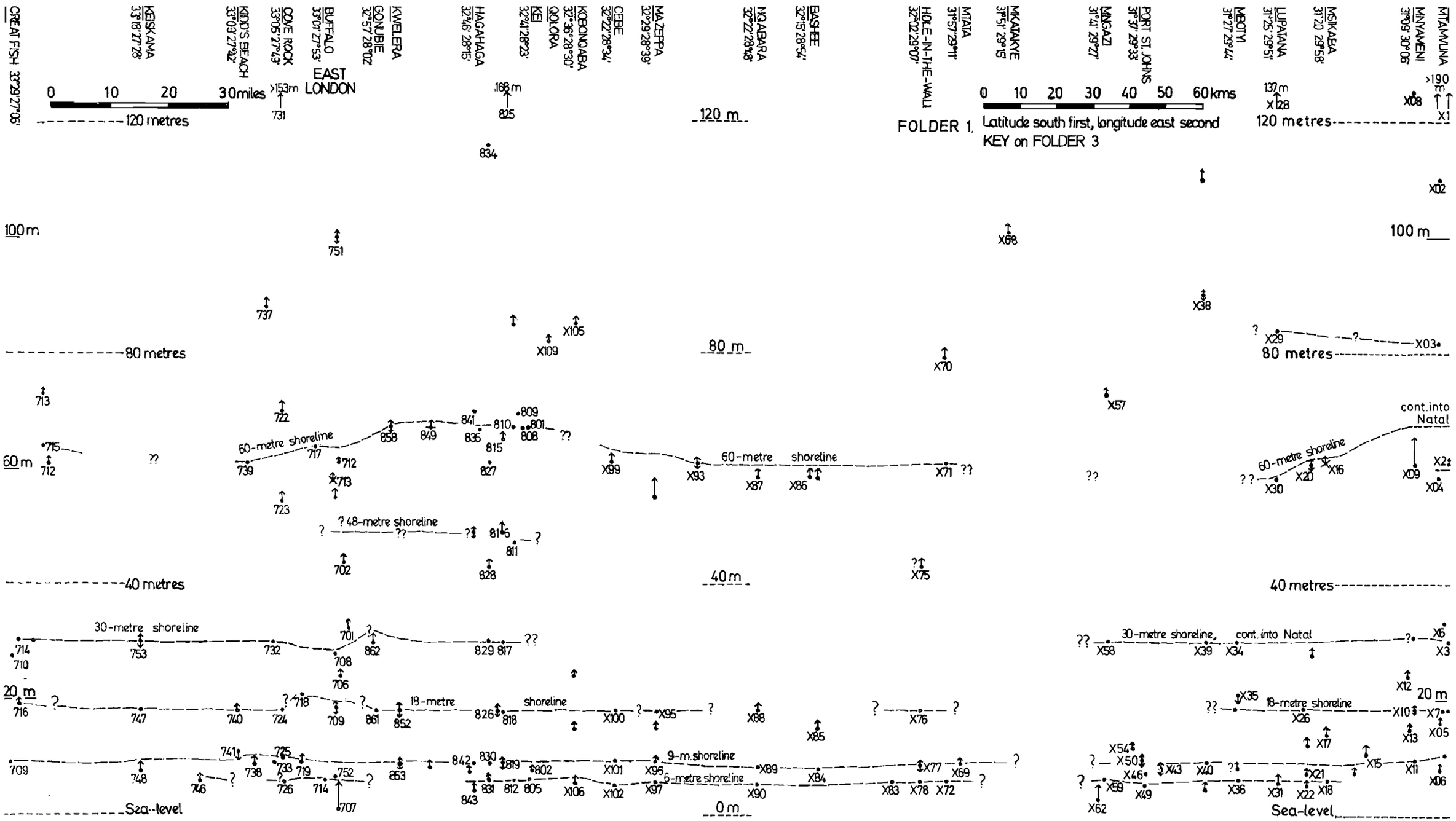
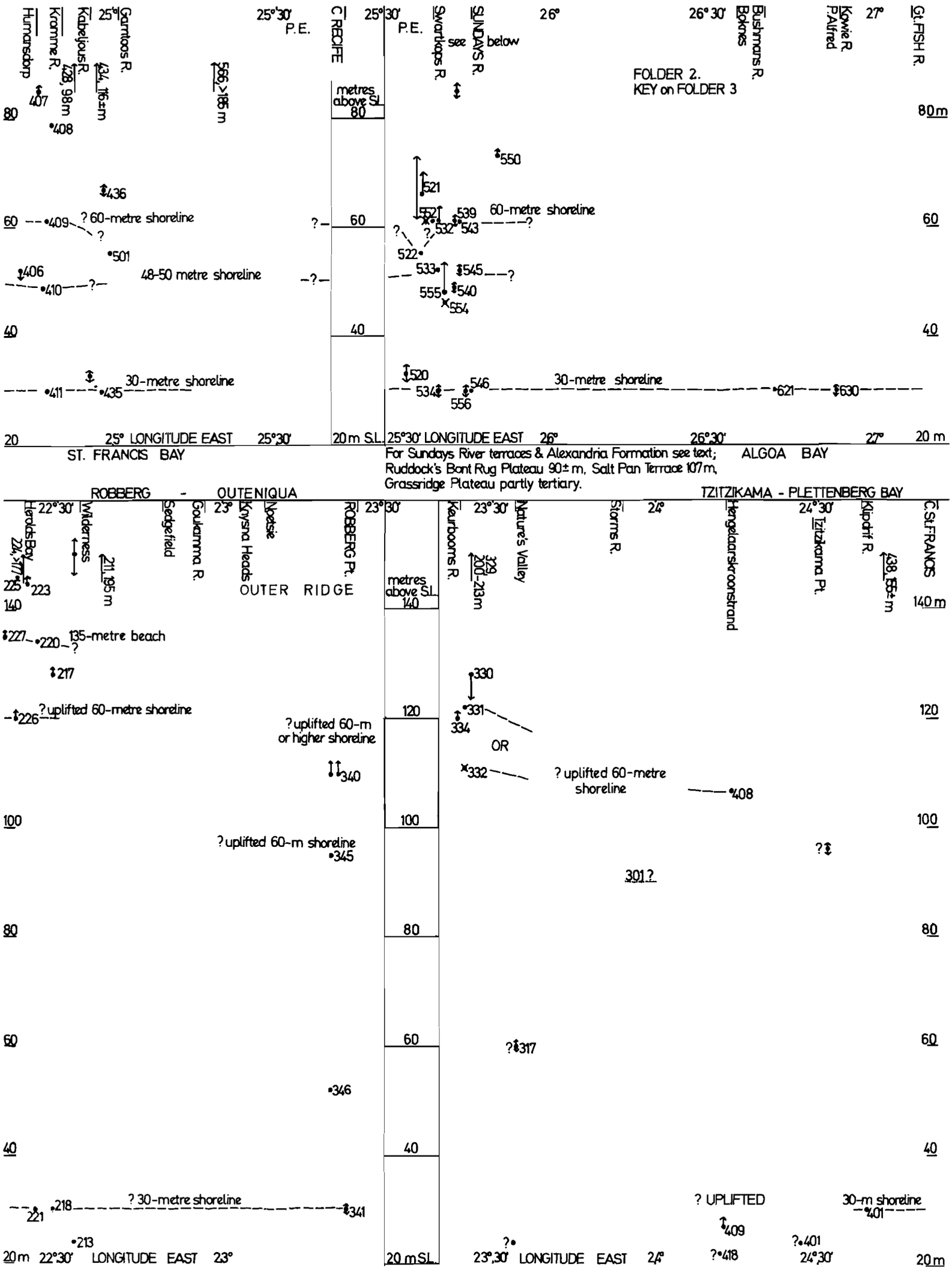


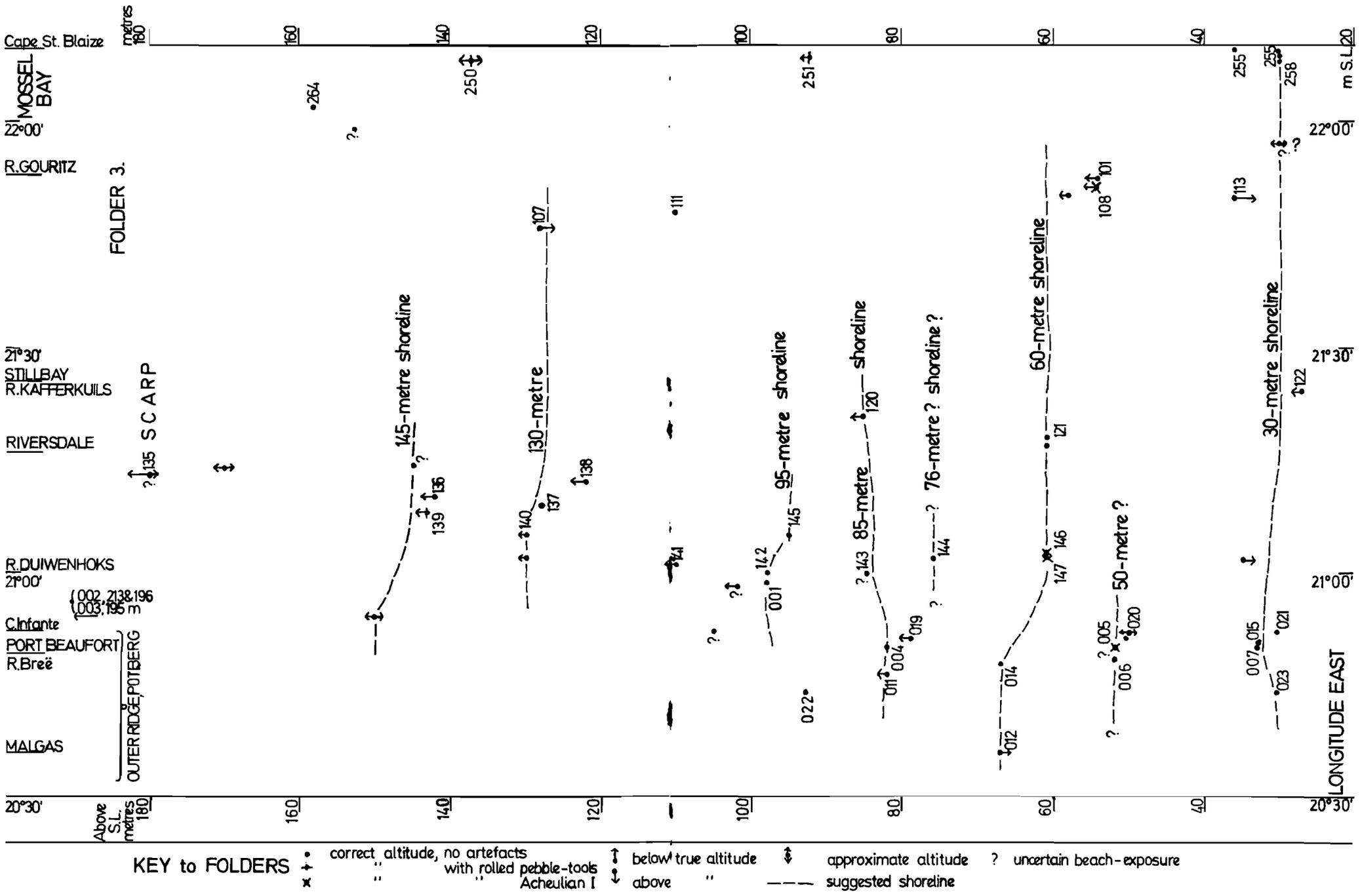
Folder 1, Section I

Vertical map of Transkei and Ciskei coast.



Folder 2, Sections II and III

Vertical map of the South Cape coast along the ridges, beaches above 30 metres S.L.
The divisions indicate troughs between the ridges.



Folder 3, Section IV

Vertical map of the coast from Cape St. Blaize to River Breë and Potberg, shorelines above 30 metres S.L.